KNOWLEDGE
AN ILLUSTRATED MAGAZINE OF SCIENCE, LITERATURE & ART.

LONDON: MARCH 1, 1897.

CONTENTS.

	PAGE
Fridtjof Nansen's "Farthest North."—Review. By Harry F. Witherby. (*Illustrated*)	57
The Victorian Era in Geography. By Hugh Robert Mill, D.Sc., F.R.S.E. (*Plate*)	60
The Origin of Some Domestic Animals. By R. Lydekker, B.A.Cantab., F.R.S.	63
On the Vegetation and Some of the Vegetable Productions of Australasia.—I. By W. Botting Hemsley, F.R.S., F.L.S. (*Plate*)	66
Science Notes	67
Notices of Books (*Illustrated*)	68
Short Notices	70
Books Received	71
Letters:—W. H. S. Monck; Fred. Enock; C. T. Hudson; David Flanery	72
Life-History of the Common Tiger Beetle. By Fred. Enock, F.L.S., F.E.S. (*Illustrated*)	73
The Chemistry of the Stars. By A. Fowler, F.R.A.S. (*Plate*)	77
The Face of the Sky for March. By H. Sadler, F.R.A.S.	78
Chess Column. By C. D. Locock, B.A.Oxon.	79

FRIDTJOF NANSEN'S "FARTHEST NORTH."*

VERY soon after Dr. Nansen's return from his now historical Polar expedition, we became acquainted, through his brief narrative in the *Daily Chronicle*, with the general outline of his wonderful voyage and still more wonderful sledge journey. Since then we have learnt from time to time a few details about the expedition, and we have lately had from his own lips, lectures which have taught us still more about that expedition—ever memorable and ever of absorbing interest.

But not until his book has been read, and the details of that which took place every day of those three long years are known, can be realized what a magnificent and what a successful undertaking it was; what hardships were gone through; what difficulties were overcome; in what a conscientious way scientific observations were performed under the most trying conditions; and, above all, what a hero every man of the expedition proved himself to be.

From the first to the last word, the book is one of absorbing interest. It never fails to excite the curiosity of the reader. What is going to happen next? How did they get over that difficulty? Such questions pass through the mind as the simple but most graphic narrative is eagerly read.

The book opens with an introduction detailing the author's theories of the currents, which he published as papers to various geographical societies, and on which he founded the plan of his expedition; how he first thought of drifting with the ice instead of fighting against it; how a special ship to resist the ice-pressure had to be built; how he contended that it was not to find "the exact mathematical point that forms the northern extremity of the earth's axis" that he was setting out, but to explore the Polar regions.

This novel and seemingly utterly reckless idea was

Scott-Hansen. Nordahl.

Observation with Sextant and Artificial Horizon, July, 1895.

(*Copyright by Archibald Constable & Co, 1897.*)

unfavourably received by almost every eminent Arctic explorer, as is well known, and it is interesting to read the objections of such men as McClintock, Nares, and others, when we have just lately heard these very men at the great meeting in the Albert Hall congratulate Dr. Nansen in the highest possible terms, and chivalrously uphold the theories which, three years ago, they so emphatically condemned.

It is not in the same terms that we can speak of General Greely, who also condemned the theories, but who now, although forced to acknowledge their correctness, casts a reflection upon the honour of one of the most honourable of men.

The details of the building of the *Fram*, undoubtedly the most ingenious and wonderful boat ever launched, will be read with keen interest. Dr. Nansen's praise for its builder, Mr. Colin Archer, a Scotchman residing in Norway, is in no way exaggerated. The chapters on "Preparations and Equipment" are of lasting interest, and will form valuable information for future expeditions.

The general route of the expedition is now well known, and it is not necessary to refer to it again. After some

* Fridtjof Nansen's "Farthest North: being the Record of a Voyage of Exploration of the ship *Fram*, 1893-96, and of a Fifteen Months' Sleigh Journey by Dr. Nansen and Lieut. Johansen. With an Appendix by Otto Sverdrup, Captain of the *Fram*." About one hundred and twenty full-page and numerous text illustrations, sixteen coloured plates in facsimile from Dr. Nansen's own sketches, etched portrait, photogravures, and maps. 2 vols. In all, 1181 pp. (Constable.) 42s.

XUM

very bad weather at the start, in which the *Fram* behaved none too well—for she is not a comfortable sea-boat—pack ice was reached, and here the *Fram* soon proved her value. The voyage through the Kara Sea was thus, notwithstanding its dreaded reputation, more successful than could have been expected, and on September 25th, 1893, the ship was frozen in fast, and the drift was begun. All on board were soon engaged in preparing for the long sojourn in the ice. All sorts of workshops were erected, and

Scott-Hansen. Nordahl.

Movable Meteorological Station on the Ice, July, 1895.

(*Copyright by Archibald Constable & Co.*, 1897.)

there was "nothing, from the most delicate instruments down to wooden shoes and axe-handles, that could not be made on the *Fram*." Then the windmill was set up which was to drive the dynamo, and produce the electric light; and, more important still, preparations were made to take regular scientific observations. A thermometer house was fixed on the ice, and meteorological observations were taken from first to last "every four hours day and night," and "for a considerable part of the time every two hours." Sounding and dredging were also frequently done. At stated periods, observations were taken to "determine the magnetic constant in this unknown region." But the observations which had most interest to all the members of the expedition were those (about every second day) to ascertain their position. Every man on board seems to have had the utmost faith in his leader and his theories, and such interest was taken in the course of the drift that "it was not uncommon to see Hansen's cabin, while he was making his calculations, besieged with idle spectators waiting to hear the result—whether we had drifted north or south since the last observation, and how far. The state of feeling on board very much depended on these results." When we look at the zig-zag line which the *Fram* took, and the necessarily slow rate at which she drifted, we can imagine that the state of feeling on board fluctuated considerably.

But there was always plenty to do for everyone; the ship proved a most comfortable home, and opportunity was wisely taken of the anniversary of every birthday, every fête day, and every memorable day—such as the day on which the sun returned to them—to proclaim a general holiday, a special feast, speeches, music, and fun. We are not surprised, therefore, that the spirits of those on board were seldom low. In the summer, when day was perpetual, amusements were of course more numerous than in the dark Arctic night. There were a few bears and many birds to be shot, and very graphically and amusingly are the hunts described. Small sledge and snowshoe excursions were undertaken on the drift ice, and even sailing could be indulged in, in small boats on fresh-water pools which formed on the top of the ice. Not the least amusing portions of the book are extracts from the *Fram* newspaper—the *Framsjaa*—which contained brilliant little articles, "local" news, poems, and even sketches.

The following extract speaks for itself:—"On account of want of storage room, a quantity of old clothes are at present for sale by private arrangement at No. 2, Pump Lane. . . . The clothes are quite fresh, having been in salt for a long time." Such, then, was the daily life on board the *Fram* during those three long years of imprisonment.

On October 13th, 1893, came the first experience of "what the prophets would have had us dread so much"—ice pressure. This is graphically described, and no boat but the *Fram* could possibly have withstood the fierce onslaught of the ice. "It is grinding itself," says the author in his diary, "into long walls and heaps high enough to reach a good way up the *Fram's* rigging; in fact, it is trying its very utmost to grind the *Fram* into powder. But here we sit quite tranquil, not even going up to look at all the hurly-burly, but just chatting and laughing as usual"—so firm was the faith in the *Fram*. Sometimes the pressure was so great that as floe after floe crushed itself against the sides of the boat, only to be driven under it and then lift it up, the noise was so terrific that those on board could not hear each other speak in the saloon; but the *Fram* stood it all, and neither cracked a board nor strained a beam.

Dr. Nansen seems to prefer the Polar night, with its lovely moon and marvellous displays of aurora and northern lights, to the continual dazzle of the Polar day. His descriptions of the aurora borealis are very fine. But in spite of his liking for the Polar night, and notwithstanding his high spirits and apparent cheerfulness, he had many a fit of home-sickness, and many a longing to see again his wife and his little daughter Liv; and this is touchingly revealed on more than one page of his diary.

In the autumn of 1894 it became apparent that the theory of the drift was proved, and that, if nothing untoward happened, the *Fram* would reach open water on the

other side of the Polar regions. But the leader of the expedition, at all events, could see that she would never reach the Pole. It was at that early date that he determined on the bold and daring feat of leaving the ship with a companion and making a dash for the Pole. This was not done without due forethought. The whole winter through Nansen was hard at work reasoning it out and preparing. Then, at last, he propounded his scheme to Sverdrup and asked his advice, and then to Johansen, and then to all the crew. And they all agreed that it was the right thing to do. Dr. Nansen knew very well, from Greenland experience, that Sverdrup could take the expedition home as well as himself, even if the ship was lost. So his preparations were made, every detail was thought out, and minute instructions were left with Sverdrup, who was to assume command.

After two false starts, Nansen and Johansen finally left the *Fram* on March 14th, 1895, with twenty-eight dogs, three sledges, and two kayaks. "I knew," says the author, "only too well that a life of toil lay before us, and that it would be many a long day before we should again sleep and eat under a comfortable roof." A life of incessant toil it certainly was, and as the simply-told tale is unfolded it is hard to understand how these two men ever lived to tell it.

The ice was fearfully rough and hummocky from first to last, and the sledges had to be laboriously dragged over the obstacles. This, and insufficient food, knocked up the dogs, and all but two had to be killed, one after the other, to provide food for the surviving ones. The cold was intense—sometimes the thermometer was as low as fifty degrees below zero, Fahrenheit. When these two brave men crept into the reindeer-skin sleeping bag at the end of a long day's toil, it would take an hour or more to thaw their clothes, which were as stiff as boards, and their boots and gloves had to be carefully dried by the heat of their own bodies. While eating their supper they would fall asleep with a mouthful of food halfway to their lips. How a diary could be written under these conditions can hardly be believed, and yet it was; and it makes very exciting reading. At about 86° 14′ north latitude, as all the world now knows, Nansen thought it prudent to go no further, but to turn and shape his course for Cape Fligely. The return journey proved to be a keen struggle for existence, and even Nansen himself seems to have given up hope in his darkest moments. But not for long; the slightest little turn of fortune brought all his courage and resolution back. At last, when all but two of their dogs were gone, and very little food was left, they reached open water and food in plenty, in the shape of bears, seals, walruses, and birds. "Joy welled up in our hearts at this sight" (the open water), "and we could not give it expression in words. Behind us lay all our troubles . . . . Such an event had to be celebrated in some way, and we did it by having a piece of chocolate each." But all their troubles were not by any means over. The dangers and hardships which were endured after this may have seemed little to them in comparison with what they had already been through, but the reader is still at a loss to understand how the strongest man could have lived through the next nine months.

Deep-water Temperature: "Up with the Thermometer."—12th July, 1894.

(*Copyright by Archibald Constable & Co., 1897.*)

How they eventually reached land, how they built a stone hut to winter in, how they made clothes, how they obtained and stored up food for the winter, how they lived through the winter's night, how they eventually found Jackson and came home, is indeed a thrilling tale told in the most captivating style, and unlucky is the man, woman, or child who does not read it.

The last portion of the book consists of a report by Captain Otto Sverdrup on the drifting of the *Fram*, after Nansen and Johansen left her, until the time she arrived in Norway. The tale is well told, and shows what a brave and capable man had been left in command.

The first work was to remove as much of the ice as

possible from around the sides of the *Fram*. An immense pressure ridge had advanced on her in the winter, and had almost buried her. It took about a fortnight's hard work to clear this ice away down to "such a depth that two and a half planks of the ship's iceskin were free." The third winter was passed through, and at the end of May, 1896, by means of blasting and hard work with the axe, these brave men managed to float the *Fram* once more from off her bed of ice. "Thus," says Sverdrup, after graphically describing how the ship was launched from the ice, "the *Fram* was free and ready to force her way through the ice as soon as the circumstances would permit." On August 14th they steered through the last ice-floes, after some wonderfully clever manœuvring, into open water. "We were free! Behind us lay three years of work and hardships, with their burden of sad thought during the long nights; before us life and reunion with all those who were dear to us." Evidently Sverdrup does not appreciate the Polar night in the same way that Nansen does.

In the concluding chapter Dr. Nansen briefly sums up the results of the Norwegian Polar Expedition. He shows that it is impossible to deal with the scientific results until the numerous observations and collections have been worked out by the specialists in whose hands they now are. The whole scientific world will anxiously look forward for these results, which may be expected in a few years' time.

In short, Dr. Nansen has proved that the Polar sea, or, at all events, this side of it, is a deep basin—not a shallow one containing many expanses of land and islands. He has proved that the ice which covers it, instead of being a solid and immovable mantle, is a floating mass continually drifting across the Pole from Behring Strait to the Atlantic Ocean. He has proved that the Polar basin, instead of being filled with water continually under the freezing point, has layers of warmer water under the cold water, and that this water is "more briny than the water of the Polar basin has been assumed to be. This warmer and more strongly saline water must clearly originate from the warmer current of the Atlantic Ocean (the Gulf Stream), flowing in a north and north-easterly direction off Novaya Zemlya and along the west coast of Spitzbergen, and then diving under the colder, but lighter and less briny, water of the Polar sea, and filling up the depths of the Polar basin." It is scarcely needful to point out to the readers of Knowledge the immense benefits which the records of this "observatory," floating in the Polar regions for three years, will confer on science. The records were most carefully and conscientiously kept by Lieut. Scott-Hansen and his assistants under the most trying conditions. To take observations of the sun and stars in seventy degrees of frost, with the breath freezing on the instruments and the bare hands getting frostbitten; to go out and take the records of thermometer and barometer at all hours of the day and night, was the every-day work of these men. Indeed, we owe to them an immense debt of gratitude.

In conclusion let us urge on everyone to read this epoch-making book and learn something—for we can never know all—of the courage and resolution of those thirteen heroes, who nobly risked their lives and underwent the most incredible hardships in the cause of science.

The illustrations accompanying this article are taken from Dr. Nansen's book, and have been courteously lent by the publishers, Messrs. Constable. It is only fair to state that the printing and binding of the book are perfect; indeed, in the whole eleven hundred pages we have only discovered two slight misprints. We are not told the names of the translators, but their work deserves great commendation—it is admirably done.

Harry F. Witherby.

THE VICTORIAN ERA IN GEOGRAPHY.

By Hugh Robert Mill, D.Sc., F.R.S.E.

QUEEN VICTORIA, in the first month of her reign, became the official head of British geographers by succeeding King William IV. as patron of the Royal Geographical Society. In addressing the Queen on the occasion, the President and Council said:—

"England has achieved some of her proudest triumphs under the sovereignty of a queen; the annals of our country record the names of Drake, the celebrated circumnavigator, and of Raleigh, the adventurous discoverer, both distinguished during the reign of Queen Elizabeth; and we confidently anticipate that the reign of your Majesty will be equally famed for its glory and prosperity, and for the promotion of geographical knowledge.

"That your Majesty's reign may be rendered illustrious as the era of important discoveries which may diffuse the blessings of civilization throughout the globe, as well as endeared to the affections of a free and grateful people, is the earnest wish and ardent prayer of your Majesty's loyal subjects, the President, Vice-Presidents, and Council of the Royal Geographical Society."

How fully this moderate and dignified anticipation was fulfilled, the record of the last sixty years attests. Perhaps the Queen has never received a dedication so perfervid as those addressed habitually to "that bright Occidental star Queen Elizabeth, of most happy memory"; but her subjects, and even the subjects of other monarchs, have delighted to plant her name on the dominant features of the Earth, as they have been unveiled in every land and on every sea. There are probably not less than a hundred place-names of Victoria on our modern maps, where sixty years ago there were half a dozen. In 1837 the name was proposed for one of the hypothetical divisions of Australia (that of the south-west), although many years elapsed before it was actually bestowed on the famous colony which now bears it. It was given to the most southerly discovered land of Antarctica, and later to an inlet of Nares Land in the remotest North; it is borne by flourishing commercial cities at both ends of the great trans-Pacific route in British Columbia and Hong Kong; it graces the largest lake of Africa and the loftiest lake of Asia; and it crowns the highest peaks of two of the remotest mountain masses in New Guinea and in Equatorial Africa. As Alexandria, the sacred city of early geography, perpetuates the memory of the world-empire of Alexander of Macedon, so will the century of Victorias on our maps keep the Victorian era in geography in everlasting memory.

The geographers of 1837 were a scattered band of distinguished explorers and men of science, whose enthusiasm was deeply stirred by the vast field for research lying before them; almost all of them have now returned for ever from their labours, bringing their sheaves of discovery and

investigation. Carl Ritter, the father of modern scientific geography, and Heinrich Berghaus, the founder of the famous physical atlas, were in Berlin; Humboldt, the ideal geographer of the period, graced the fashionable world of Paris; Jomard, D'Avezac, and Vivien de St. Martin were amongst the more prominent of the numerous French geographers; Krusenstern, who watched over the vast family of Pacific islands as if they were his children, and Wrangel, of Arctic fame, worthily represented Russia; while Paul Chaix, happily still in full mental vigour, was prominent in Switzerland. Maury, in America, was engaged in the studies which led to his great work on the physical geography of the sea; and in Great Britain, Parry, Franklin, Back, and Ross were famous Arctic heroes; Biscoe had reawakened interest in the Antarctic seas, Vidal had given his name to the extension of the Continental shelf beyond the British Islands, Murchison and Charles Darwin were already recognized as clever observers, and the great Arrowsmith was producing his exquisitely engraved maps, such as have not gladdened the eyes of geographers for a generation past. As regards British travellers, they were in all parts of the Earth. Ainsworth was exploring Asia Minor; he died in December, 1896, the *doyen* of British explorers, and second in seniority among European travellers only to the veteran D'Abbadie, who still survives. Everest was pushing on the great Trigonometrical Survey of India, which has fixed his name on the greatest mountain in the world; Africa had just claimed as a victim the intrepid Davidson, while making his way across the Sahara to Timbuktu; Alexander had penetrated from Cape Colony to Namaqualand; and British surveying ships were engaged in constructing for the whole coast of Africa charts which "may be said to have been drawn and coloured with drops of blood," so terrible was the mortality among the crews before the elements of tropical hygiene had been learned. The Hudson Bay Company's officers were exploring the Arctic coast of America, and the Danish Antiquarian Society had just published the first absolute proof of the discovery and colonization of America by the Northmen in the tenth century. Schomburgk was engaged in surveying the frontier regions of British Guiana, and stirring up a controversy the end of which it is, perhaps, not unduly optimistic to look forward to in the sixty-first year of Her Majesty's reign. In Australia numerous exploring parties were in the field, and a town called Melbourne was founded on Port Philip Bay, in the south of New South Wales.

Within the space of a single article it is only possible to glance at one aspect of the progress of geography during the sixty years of the Victorian era; and, perhaps, the best aspect to adopt for such a purpose is that of discovery and exploration, for in it British work has been pre-eminent. In other aspects the comparison of British geography in 1837 and 1897 might produce disappointing results. The problems of general scientific geography formulated by the President of the Royal Geographical Society in 1837, and put forward by him as deserving of immediate attention, are to a discouraging extent still problems of the future. This has been largely due to the lack of international co-operation, and the mutual independence of the workers in different countries—a state of things which the development of international congresses in recent years may be hoped soon to improve.

In attempting to sketch the main lines of the progress of geographical exploration, we must leave out of account the steady progress in surveying and mapping the countries of Europe and other continents which have resulted in such triumphs of cartography as the Ordnance Survey of the United Kingdom and the great Trigonometrical Survey of India; nor can we refer in detail to the charting of the coasts of the world by the surveying ships of Europe and America.

Arctic exploration has always been viewed with interest and often enthusiasm, but never have the romance and tragedy of exploration held so sustained a hold upon the world as during the fifteen years which followed the despatch of Sir John Franklin in 1845. In that year the *Erebus* and *Terror*, just returned from the Antarctic, sailed to complete the survey of the Arctic coast of America and achieve the North-West Passage. Towards the end of the summer they were seen by a whaler in Melville Bay, and this was the last direct news. In 1848 Sir James Clarke Ross started on the first search expedition, and during the next few years ship after ship went out through Lancaster Sound on the east and Bering Strait on the west, while land-parties under the guidance of Hudson Bay Company's officials descended the northern rivers and searched along the coast. The Arctic archipelago was very fully explored in this way; in 1850 no less than fifteen vessels were prosecuting the search for the missing ships. In that year Captain McClure, who had entered by Bering Strait in the *Investigator*, discovered the North-West Passage—the vain dream of the merchants of the sixteenth century—but he found the ice conditions so severe that he had to abandon his ship and return by one of the vessels pursuing the Franklin search from the eastward. In 1855, after the discovery of undoubted relics of the lost ships by Dr. Rae, the British Government abandoned the search; but the devotion of Lady Franklin, and the determination of the public to discover fuller details, led to the splendid private expedition of the *Fox*, from 1857 to 1859, in which Sir Leopold M'Clintock and Sir Allen Young explored nearly a thousand miles of new coast-line under conditions of the greatest difficulty, and discovered the only document throwing light on Franklin's fate which has been found. It proved that to Franklin belongs the honour of first discovering the famous North-West Passage.

In 1871, Captain Hall, in the American steamer *Polaris*, entered Smith's Sound and reached the highest latitude so far attained—82° 16′ N. In the following year an Austro-Hungarian expedition under Payer and Weyprecht were carried by drift ice from Nova Zemlaya and discovered Franz Josef Land, the remote region in which the English explorer Jackson and his party have been at work for the last three years. The great British Government expedition of the *Alert* and *Discovery*, under Sir George Nares, penetrated Smith Sound in 1875; and Commander A. H. Markham led a sledge party to 83° 20′ N., which remained the highest observed latitude until Lockwood, of Greely's American expedition, reached 83° 24′ north of Greenland, in 1882. In 1878-79 the Swedish professor Baron Nordenskiöld accomplished the North-East Passage in the *Vega*, and circumnavigated the continent of Eurasia for the first and only time. Peary in three successive years made some of the finest journeys every accomplished over the inland ice of Northern Greenland. Great as these achievements were, they have been excelled by the scientifically planned expedition of Dr. Fridtjof Nansen in the *Fram*. By relinquishing the time-honoured plan of following a coast-line, or fighting against drifting ice-floes, and allowing the moving ice of the Polar basin to carry his ship, he succeeded in drifting from near the New Siberian Islands to Spitzbergen, across an absolutely unknown area. In his sledge journey, alone with his companion Johansen, he reached 86° 14′ in 1895, an advance of nearly two hundred miles on the farthest north ever made before; and his expedition in its safety, success, and exact conformity to the plans previously laid down

XUM

must be looked on as the culmination of Arctic travel in the Victorian era.

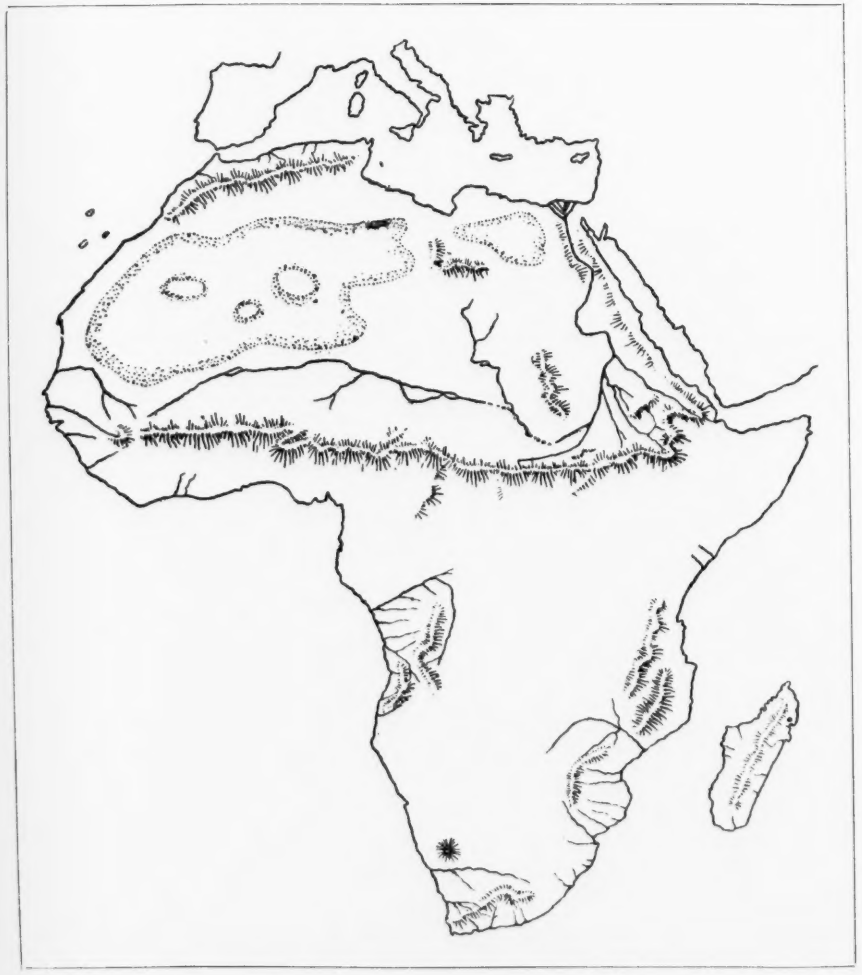
Whether the Antarctic regions are to yield their secrets in this century or in this reign is extremely doubtful. Sir James Clarke Ross led his great expedition round the southern ice in 1841, and left the names of his ships, *Erebus* and *Terror*, on the lonely volcanoes that no human eye has since looked upon. The *Challenger*, in the course of her voyage thirty years later, just crossed the border of the Antarctic area, and but for the visits of whalers from Scotland and Norway during the last four years, there has been no farther advance. At this moment several Antarctic expeditions are talked of, and one is announced as ready to sail from Belgium in July, 1897. The field before it is wide.

Next to the Polar areas Africa is the region in which the explorations of the last sixty years have led to the most striking advances of knowledge. In 1837 this truly deserved its name of the "Dark Continent," for nothing was known save the coast-line, the Lower Nile and Abyssinia, a few tracks across the Sahara, the River Niger, a portion of the Zambesi, and a small area north of the Cape of Good Hope. The fanciful detail of interlacing lake and river systems had been cleared away by D'Anville a century before, and the map stood swept almost bare, garnished only with the newly-traced Niger, and the hypothetical chain of the Mountains of the Moon stretching across from Guinea to the Indian Ocean. The trade of centuries on the West Coast had led to no explorations worthy of the name, and it was not until the missionary travels of Dr. David Livingstone in the fifties that any real interest was evinced in the continent as a whole. As a pioneer of African discovery Livingstone may be looked upon as the initiator of the modern period, and in his methods of work and his treatment of natives he remains a model for all time. His discovery of Lake Nyassa in 1859, Burton's discovery of Tanganyika in 1858, Speke's of the Victoria Nyanza in 1859, and Baker's of the Albert Nyanza in 1862, threw open the great lake region of East Africa along its whole length; and the main lines of the geography of the eastern strip of Africa under the rule of the Sultan of Zanzibar were quickly laid down by an increasing number of explorers. The sources of the Nile have exercised a fascination for travellers in Africa like that of the search for the North-West Passage or the North Pole for Arctic voyagers; and in pursuit of these sources Livingstone was tracing the great river Lualaba, which flowed northward west of Lake Tanganyika, to its source in Lake Bangweolo, when death overtook him in 1873. Believing that his great river was the Nile, he could not yet resist the suspicion that it might after all turn out to be the Congo. This supposition was turned into certainty by Mr. H. M. Stanley's magnificent journey of 1877, when he traced the Lualaba round its great Equatorial bend, and opened up the vast waterway from Stanley Falls to Stanley Pool on his way to the sea. Cameron had before made a crossing of Tropical Africa farther south, but no journey in Africa has been so fateful as that of Stanley down the Congo. It led to the foundation of the Congo Free State and the opening up of the whole great river to steamer traffic, affording a base from which the northern and southern tributaries could be explored to their sources. In 1884 commenced the "scramble" of the European Powers for African possessions, and the resulting partition of the coast into spheres of influence, whence the explorers of each nationality pushed inland in the effort to secure the Hinterland and command the sources of internal trade. The remotest deserts of the Sahara, isolated parts of the Equatorial forests, and a portion of Somaliland, are the only regions now remaining entirely unknown.

Turning to the vast continent of Asia, we see a region in which the motives for exploration are in some ways different. As in Africa, the encroachment of European Powers has pressed heavily upon the native states from several sides; but alteration of frontiers now proceeds slowly by treaty, and the attention of explorers is directed mainly to the completion of the long-delayed rough surveys of routes and physical features.

W. Gifford Palgrave and Burton have made known some of the least accessible parts of Arabia, much of which still remains unknown.

The operations of the Survey of India are perhaps the most remarkable of the geographical advances in Asia during the last sixty years, leading as they have done to the exploration of the border lands of that empire. Much remains to do before the noble range of the Himalayas is fully known even on its southern face, for the political system of the Indian Empire respects the independence and exclusiveness of the border tribes, and practically prohibits exploration by Europeans in many places. Trained natives of India, employed on the initiative of Colonel Montgomery, have, however, solved many problems of geography in the forbidden lands, traversing the Himalayan passes, residing in the sacred city of Lhasa itself, and proving the true course of the Brahmaputra River. Expeditions of Survey officers have linked the Indian triangulation with that of Russia through Baluchistan and Persia, and across the passes of the Hindu Kush. The study of Kafiristan by Sir George Robertson in 1890 was a remarkable instance of the way in which such dangerous and little known valleys as those of the Kafirs can be entered safely by prudent and tactful explorers. Long journeys in the interior of Asia, made largely by British officials on political expeditions or on holiday excursions, have enabled the outline of the mountain system surrounding the vast plateau of Tibet to be filled in. The names of only a few can be mentioned as types of the many. Hayward, who in 1868 crossed the Kuen-lun to Kashgar and Yarkand, perished in Central Asia; but the route he opened is now frequently traversed. Wood, who explored the source region of the Oxus in 1840, first gave correct views regarding the Pamirs, which, thanks to the visits of innumerable sporting expeditions, and the Russian and Indian Delimitation Commission, is now thoroughly well known. Mr. St. George Littledale, whose great journey across Tibet from north to south compares with that of Captain Bower from west to east, is an example of a sportsman who has trained himself to become an efficient geographer. Mr. Ney Elias, in 1871, and Lieut. Younghusband, in 1889, have made themselves famous by their journeys from China through the desert belt which intervenes between the Tibetan plateau and the Siberian plain. In the same regions the great Russian traveller Przhevalski and his successors have set in order the physical map, and discovered many curious features of river, lake, and valley. The French, since the time of Abbé Huc, have been to the front in the exploration of Eastern Asia. Garnier's pioneer journey by the Mekong from Cambodia to China, Prince Henry of Orleans' crossing of Tibet, and his journey from French Indo-China to India, are important instances. The American Rockhill did much to elucidate Tibet and Mongolia; while the labours of the Swedish explorer Sven Hedin, during the last few years, have resulted in a thorough scientific study of Eastern Turkestan and its bordering mountains on the west. The work on China by Baron von Richthofen is as perfect an example of the late Victorian methods of geographical research as the descrip-



MAP OF AFRICA, as published in 1837.

MAP OF AFRICA, indicating the more important Modern Discoveries.

XUM

tion of Asia by his countryman, Carl Ritter, was of the early Victorian style of geographical literature. Blakiston, Cooper, and Gill were amongst the pioneers in opening the interior of China to European knowledge. The phenomenal progress of Japan in Western civilization has, of course, led to a vast advance in geographical knowledge concerning that remarkable archipelago; and slower progress has been made in the rich islands of the Malay Archipelago, where the travels of Wallace have been followed by the researches of many other naturalists.

The interior of Australia has been opened up, save a few patches of desert in the west and centre, entirely within the period under review. Nowhere has more heroism been shown by travellers, and no travellers have received scantier recognition by the public than those who have made known the interior of the only entirely British continent. The names of Eyre, Sturt, Leichhardt, the two Gregories, Burke, Forrest, and Giles, are too unfamiliar to English readers, although all have been honoured by geographical authorities, and the romance of their exploits will some day be adequately told.

The great island of New Guinea has been to a large extent explored by the British, Dutch, and Germans who administer its various divisions; and the present Governor of British New Guinea, Sir William Macgregor, has earned for himself a place in the history of the island only comparable to that of Livingstone in the history of Africa.

In North America the last sixty years have seen the evolution of a complete system of political geography, the dividing lines of which are dependent on accurate surveying. The survey is still very far from complete, but the period of great discoveries is nearly past—discoveries, that is, of the magnitude of the great cañon of the Colorado, the River Yukon in Alaska, or the Grand Falls in Labrador, all of which fall within our period. Fremont's explorations of the Far West in the forties, and the Kings' exploration of the fortieth parallel in 1870, ought to be specially remembered. The Geological Surveys of the United States and of Canada, as well as the special Surveys of the individual States, are constantly engaged in geographical work of great importance, in the pursuit of which a distinct school of American geographers has grown up.

South America was, of all continents, the most rapidly explored as far as its main outlines are concerned, and such work as has been done within our period has been chiefly the better mapping and more complete tracing of river systems, the climbing of mountains like Roraima, Chimborazo, and Aconcagua, and the exploration of the wildernesses of the Gran Chaco and Patagonia. The naturalist geographers of South America did not die out with Humboldt. The works of Wallace, Bates, and Von den Steinen in the Amazon district, Schomburgk and Im Thurn in Guiana, Burmeister and Hudson in the Argentine Republic, will never be forgotten.

Space makes it necessary to merely mention the creation of the great science of oceanography in the Victorian era. The cruise of the *Beagle*, with Darwin on board, may be said to have passed on the torch kindled by Cook to the Antarctic expedition of Ross. Observations made casually in these cruises were systematized by Maury, who, with the force of his magnificent enthusiasm, has given a vitality to his "Physical Geography of the Sea" which enables that unique work to survive the theories it propounded. The voyage of the *Challenger* and the progress of telegraph surveys gave a secure basis for the study of oceanography, and many minor expeditions have since advanced it. The time is now ripe for another well-organized and fully-equipped expedition for the study of the oceans.

Be the restraints of space what they may, it would be impossible to conclude without a few words on the services to geography rendered during the Queen's reign by those of her own sex. At the accession, Mrs. Mary Somerville was the best physical geographer in Great Britain, and her distinction won for her the gold medal of the Royal Geographical Society in 1869, an honour only accorded to one other woman, Lady Franklin. In 1842, Frau Ida Pfeiffer commenced her wanderings, which covered almost every quarter of the globe and led to a number of popular books of travel; and since then Miss North followed in her footsteps in search of flowers to study and paint in all climates. Miss Gordon Cumming, the indefatigable Mrs. Bishop, Lady Brassey, and Miss Kingsley have performed feats of travel far beyond the average of globe-trotters or pleasure-seekers. Lady Baker accompanied her husband on his expedition up the Nile to the Equator, and Mrs. Peary stayed by her husband during an Arctic winter in Northern Greenland. The ill-fated Mlle. Tinné lost her life in the attempt to penetrate the Sahara. Mrs. Theodore Bent has accompanied her husband into parts of Africa and Arabia where no white woman has been before. Lady Anne Blunt, in another part of Arabia, rendered real services to geography. It would be impossible to enumerate the noble company of lady missionaries who have followed hard on the explorer and trader into the inmost recesses of Africa and Asia, sometimes, as in the case of Miss Taylor, who went far into Tibet, even opening up entirely new ground.

The great names of the British geographers at the beginning of the reign find worthy counterparts at the sixtieth anniversary—men of the originality of Mr. Francis Galton, the versatility and wide knowledge of Sir Clements Markham, and the scientific strength of Dr. John Murray of the *Challenger*. Nor are the names of General Strachey, Admiral Wharton, Ravenstein, and Bartholomew likely to be soon forgotten, or their influence on the progress of geographical science to be effaced.

Abroad, the scientific geographers of the present day are more numerous than at any previous time. In physical geography, Suess and Penck in Austria, Richthofen and Supan in Germany, De Lapparent in France, and W. M. Davis in the United States, are representative of the most modern developments of geography. Elisée Reclus must be mentioned as the author of the most important treatise on general geography of modern date; and only the impossibility of adding names to an article already overburdened with them, prevents us from paying a well-deserved tribute to a hundred more.

THE ORIGIN OF SOME DOMESTIC ANIMALS.

By R. LYDEKKER, B.A.Cantab., F.R.S.

FEW subjects are hidden in greater obscurity than is the origin of many of our domestic animals; and seeing that man in all probability began to exercise his power of dominion over the wild creatures by which he was surrounded at a very early date indeed, this is nothing more than might be expected. When animals were first domesticated, and which were the species that first came under the yoke of servitude, we shall never know. The available evidence points, however, very clearly to the conclusion that Asia was the great original centre of the early domestication of Old World animals; although North-Eastern Africa seems also to have participated to a certain extent. So far as it goes, this tends to confirm the conclusion that Asia has been the cradle of the human race, although it must be borne in mind that different races exhibit wide differences in their capacity for domesticating animals; those of Africa being far inferior in this respect to many Asiatic tribes.

XUM

When any species of animal—provided that it will breed in this state—had once been domesticated, it is probable that the descendants of such domesticated stock have formed the basis of all or most of the later breeds; for it is obviously much easier to train such stock than to commence again *de novo* with a wild strain. Still, there are many cases where subsequent crosses have taken place with a wild race, or races. From the point of view of their origin, domesticated animals may be divided into three classes. In the first class we have those which but seldom, or never, breed in captivity, and of which the domestic race has constantly to be replenished by the capture and training of wild individuals. Apparently, the only two mammals coming under this category are the Indian elephant and the hunting-leopard. The latter can, however, only by courtesy be termed a domesticated animal, and may accordingly be dismissed from further notice. With regard to the elephant, the most curious feature is the readiness with which wild individuals submit themselves to servitude, and the aptitude they display for learning their allotted duties. Fortunately, the elephant is an extremely long-lived animal, and therefore it has time to learn much during its period of captivity, while the necessity for fresh captures is proportionately diminished. Modern naturalists insist—and rightly so—on the inferiority of the intelligence of the elephant as compared with that of many domestic creatures: the dog, for instance. But it is generally forgotten that, in consequence of its not usually breeding in captivity, there is no domestic race which has acquired the experience and docility of years of servitude. And it is a subject for reflection to consider what might be the intellectual capacity of this animal had it been in continuous domestication for as long a period as the dog. In the second class come those animals of which the ancestral wild stock is either still existing, or was so within the historic or prehistoric period. In this category come the horse, ass, ox, goat, and probably the cat and dog. The third class includes those domesticated animals of which the wild stock is not only extinct, but is likewise totally unknown. The best example of this class is the camel; but it is probable that the sheep must also be included.

Commencing with the camel, it is probably known to most of my readers that there are two kinds of this animal—namely, the two-humped Bactrian camel (*Camelur bactrianus*), of Central Asia, and the one-humped Arabian camel (*C. dromedanus*), now common to Asia and North Africa. Although it has been affirmed that wild Bactrian camels occur in the deserts of Turkestan, it is almost certain that these are descendants of a domestic race which escaped from captivity about two hundred and fifty years ago. Consequently there are no truly wild camels in existence. The only clue as to the original habitat of the genus is afforded by the remains of fossil camels in North-Eastern India and Algeria; and as the former occur in the older deposits, it seems probable that Central Asia is the cradle of the race. Naturalists regard the two kinds of camels as distinct species; but we have no absolute proof that they may not both be domesticated races derived from a single wild stock. And some confirmation of this suggestion is afforded by the llama and alpaca of Peru, both of which are domesticated races tracing their ancestry to the wild guanaco. At what period the camel was first domesticated is lost in the mists of antiquity. From its absence from the Egyptian frescoes, it has been stated that this animal was unknown to the early inhabitants of the Delta of the Nile; but this is controverted by a papyrus of the fourteenth century B.C., in which reference is made to camels.

Considering the very large number of existing wild species of the genus ovis, it is a very remarkable fact that we are unable to point to the ancestral stock of the sheep. As we know them in this country, domestic sheep differ from their wild kindred by their woolly fleece, the wild species having hair more like that of a deer. But as some of the native domestic sheep of Asia and Africa have a more or less woolly pellage, the difficulty does not lie here. With the single exception of the arnu, or Barbary sheep (*Ovis tragelaphus*), of Northern Africa, all wild sheep have short tails; whereas in the domestic races this appendage—until docked—is very long. The reader may ask why we do not regard the arnu as the parent stock. To which question it may be replied that the latter species has smooth horns, with a curvature quite unlike those of any of the domestic races, which approximate to the horns of the Corsican mouflon. It seems somewhat difficult to believe that a long tail can have been developed from a short tail—as precisely the opposite development is the only one with which we are acquainted; but, nevertheless, it has been suggested that the long tails of the domestic breeds are a kind of degenerate development. If this be substantiated, there is no reason why the mouflon—which in former times probably had a wider distribution—or some allied Asiatic species, should not have been the original progenitor of the domesticated breeds. A small breed of long-legged sheep, with somewhat goatlike horns, was in existence at the long-distant epoch when the inhabitants of the Swiss pile villages flourished. So far as it goes, this form suggests that the domestic breeds are derived from an extinct species. Although domestic breeds were possessed by the ancient Egyptians, the sheep represented on the frescoes, according to the late Prof. Leith-Adams, is the wild arnu.

With the domestic goats the case is very different; it being practically certain that most, if not all, of the breeds of Europe and Western Asia are derived from the Persian wild goat, or pasang (*Capra ægagrus*), which ranges from Asia Minor through Persia to Afghanistan and Sind. This handsome species has long scimitar-like horns, with the front surface forming a sharp ridge, instead of being flattened and knobbed, as in the ibex. Many domestic breeds have very similar horns; but in others, especially from Central Asia, the horns are more or less corkscrew-like. As the wild markhor (*C. jalconeii*) of the Himalaya has horns of a similar type, it has been suggested that many of the Asiatic breeds are derived from that species. Against that view is the circumstance that the direction of the spiral in the domestic ram is generally, although not invariably, just the reverse of that in the markhor. Although it is probable that some Asiatic rams may trace their origin to the latter, it is more probable that they are derived from the pasang but have been crossed with the markhor. Most likely the goat was first domesticated in Western Asia, whence it was imported into Africa, where it has departed very widely from the original type. A superstition prevails in countries so wide apart from one another as Scotland and Kashmir that goats are deadly foes to snakes (the name "markhor" signifying *snake-eater*), and it would be very interesting to discover whether the legend has any foundation in fact.

The numerous breeds of domestic cattle of Europe all trace their ancestry to the great extinct wild ox, or aurochs (a name frequently misapplied to the bison), which lived on in England at least as late as the Neolithic period, and survived to a much later date on the Continent. It has been thought that the white wild cattle of Chillingham Park are the direct descendants of the aurochs, although it is far more probable that they are

derived from a domestic breed, as it is in the highest degree unlikely that the original species was white. Many breeds, such as the so-called Celtic shorthorn, were established at an early period of our history; and these have been incorrectly regarded as distinct species, although there is no doubt that they have the same ancestry. The geographical range of the aurochs was very extensive, and the original domestication may have taken place in Western Asia. The humped cattle of India seem to trace their origin to a distinct species now extinct, and the ancestral form may perhaps be looked for among the extinct oxen whose remains are found in the gravels of the Narbada Valley. Some have, indeed, considered that humped cattle originated in Africa, where they are represented by the so-called Galla ox; but it is far more probable that they are really of Oriental extraction and have been introduced into the Dark Continent.

During the immense period that they have been domesticated the true oxen have displayed great adaptability to modification, as is exemplified by the difference between such breeds as Highland, Polled Angus, Galloway, Kerry, Devon, Longhorns, Shorthorns, and Jersey. Not so the buffalo of Asia, which, although long domesticated in India, and subsequently introduced into Egypt and thence into Italy, has in nowise departed from the wild type, save as regards a somewhat smaller stature and a diminished length of horn. Certain other species of cattle, such as the gayal (*Bos frontalis*) of Tenasserim, and the banting (*B. banting*) of the Malay countries, have been more or less domesticated by various Oriental races, although, in most cases, the domestic breed seems to be renovated from time to time with a cross of the wild stock. All these forms seem to be unadapted for variation, and consequently breed true. No attempt ever seems to have been made to domesticate the bison; while, true to their instincts, the natives of South Africa have never enthralled the buffalo of that country.

Till within the last few years the origin of the domestic ass was a matter of some uncertainty, seeing that all the Asiatic wild asses differ considerably from the familiar animal. Recently, however, an ass has been discovered in Somaliland which differs in no important character from the domestic form, and is its undoubted ancestor. Some of these Somali asses are, it is true, more striped on the legs than is commonly the case with the domestic breed; but then some examples of the latter are nearly or quite as fully marked as the wild race, while some African specimens have nearly uniformly coloured limbs. Possibly the Somali wild ass may originally have ranged into Syria and Arabia; and, in any case, it is probable that it was first tamed there, and thence introduced into Europe. Indeed, the Greek name (*onos*) of the ass is stated to be derived from a Semitic root; and since this name occurs but once in the "Iliad," and not at all in either the "Odyssey" or in Hesoid, it has been inferred that the ass was a rare and little-known animal in Greece during the epic period.

Whether there are any truly wild horses at the present day is a moot point. The only animals that can lay claim to that title are the so-called tarpan of the steppes of Central Asia, which formerly ranged as far westward as the Volga. Some authorities are of opinion that these tarpan are a truly wild race, while by others they are regarded as feral—that is to say, descended from a domesticated stock. It is undoubted that the droves of tarpan at times receive an influx of feral animals; but whether they be feral or truly wild—and the evidence seems rather in favour of their wild origin—they undoubtedly resemble the ancestral type of the horse. This, of course, will be due in the one case to reversion, and in the other to direct inheritance. They are rather small, clumsily built animals, with remarkably ugly heads, their general colour being dun. During the Pleistocene period horses of similar type to the tarpan wandered over a great part of Europe and Western Asia, as is attested by their fossilized remains; and from other evidence it is probable that at the epoch in question the physical condition of much of Europe was similar to that of the Asiatic steppes at the present day. Such conditions would seem, indeed, to be essential for the existence of wild horses, which are animals specially adapted for a life on the open plains, where they find safety in flight. It is true that wild horses were found in parts of Europe at a much later epoch, when the country had become forest-clad; but it is quite possible that these were really feral races. When we come to the consideration of the place and time of the first domestication of the horse, the usual difference of opinion prevails among those most capable of forming a judgment. It was at one time considered that the horse was first domesticated in the East, but later authorities are more inclined to think that the wild horse was also subjugated by the stone-implement makers of Western Europe. Such race is considered to have given rise to the ordinary European breeds; but thoroughbred horses are probably of Eastern origin. Whether both the Western and Eastern breeds were derived from the tarpan cannot be determined; but it is evident that the latter breed either originated from an animal with more "blood," or that more attention was paid to its development. We naturally look to Arabia as the ancestral home of the Eastern race; but this is a mistake, as the horse is known to be a comparatively late introduction into that country, the Arabs even as late as the time of Strabo having neither horses nor asses, and coming to battle mounted on camels.

In the early days of Egypt—that is to say, during the period known as the "old kingdom"—the horse was unknown in the Nile Valley; the animal not making its appearance in the frescoes till about the year 1800 B.C. Probably the horse entered Egypt *viâ* Mesopotamia and Syria, where, as we learn from the Nineveh sculptures, it had long been known. It has been well remarked that even these sculptures afford evidence that the horse was a comparatively new animal to the Assyrians—that is to say, these warriors were not such splendid riders as were the Parthians at a later date, and as are the Turkomans now. If any of my readers will visit the British Museum and inspect the Assyrian sculptures, he will scarcely fail to notice that, whereas those mounted warriors who are armed with the spear manage their own horses, such as carry a bow have their horses led by a comrade. Manifestly, the Assyrian warrior was incapable of managing his steed when both his hands were occupied with his weapon; and he was thus a far less accomplished horseman than the Parthian or the Turkoman.

Although the evidence is not decisive, the probability is that the horse was first introduced into Assyria from Persia. The ancient records of India indicate that horses were by no means common there, while such as there were excelled neither in strength, speed, or beauty. The Indian climate is, indeed, unsuited to the animal; and there is no doubt that it was originally introduced from the North. But the original horse must have come from somewhere, and the probability is that the nomad Mongols in the East and the Turkomans in the West—still some of the most splendid horsemen the world has ever seen—were the first Asiatic tribes to subdue the noblest of man's servants. This being so, and Turkestan and Mongolia being the home of the tarpan, it follows—if our premises are true—that not only are the latter really wild animals, but that the thoroughbred of the East has the

XUM

same ancestry as the underbred animal of the West, and consequently that "blood" is merely a matter of careful selection and breeding for countless centuries, and is not due to inherent superiority of origin. From the plains of Turkestan the horse spread in one direction to the Punjab and the plains of Hindustan, and in the other through Persia to Mesopotamia and Assyria, and thence westwards to Egypt and southwards to Arabia. Among the Arabs it soon became indispensable to its master; and, as already said, this intimate union between man and quadruped renders it difficult to believe that Arabia is not the original home of the horse. Uncivilized races, though highly conservative in some matters, in others soon adapt themselves to new circumstances; and the case of the North American Indians affords an example of the rapidity with which a people among whom the horse was unknown can develop into a race of horsemen. Had we not historic evidence to the contrary, there is, indeed, no saying but that the original subjugation of the horse might not have been attributed to the Indian of the prairies.

When I began this article, I hoped to say something as to the origin of the cat and dog, but this must be reserved for a future occasion.

ON THE VEGETATION AND SOME OF THE VEGETABLE PRODUCTIONS OF AUSTRALASIA.—I.

By W. Botting Hemsley, F.R.S., F.L.S.

THE more comprehensive geographical term Australasia is employed in the heading of this series of articles, because, although the vegetation of Australia proper is the main theme, comparisons are occasionally made with the vegetation of New Zealand, Tasmania, and other islands.

It seems almost incredible that less than two hundred years ago absolutely nothing was known of so vast a country as Australia, and that little more than a century has elapsed since the foundation of the first settlement; but such is the case. In 1699 the renowned Captain William Dampier sailed from England in command of H.M.S. *Roebuck* on a voyage of discovery to West Australia, he having previously, on a voyage of adventure, touched at a point of North-West Australia.

Dampier was a keen observer, and he devoted special attention to the vegetable productions of the various countries which he visited. He, unlike the commanders of most of the great subsequent expeditions, carried no naturalist; but he was no mean naturalist himself for the period, and few of his successors have written so well on natural history. The part of Australia he visited on the north-west coast was exceedingly barren, and his description of it was not such as to tempt other navigators, or would-be colonists. A few sentences from his account of his first visit will give an idea of his impressions of the country:—

"New Holland is a very large tract of Land. It is not yet determined whether it is an Island or a main Continent; but I am certain that it joyns neither to Asia, Africa, nor America. This part of it that we saw is all low even Land, with sandy Banks against the Sea, only the points are rocky, and so are some of the Islands in this Bay.

"The Land is of a dry sand soil, destitute of Water, except you make Wells: yet producing divers sorts of Trees: but the Woods are not thick, nor the Trees very big. Most of the Trees that we saw are Dragon-trees [gum trees or *Eucalypti*] as we supposed; and these too are the largest Trees of any there. They are about the bigness of our large Apple-trees, and about the same heighth: and the rind is blackish, and somewhat rough. The leaves are of a dark colour; the Gum distils out the knots or cracks that are in the bodies of the Trees. We compared it with some Gum Dragon, or Dragon's Blood, that was aboard; and it was of the same colour and taste. The other sorts of Trees were not known by any of us. There was pretty long Grass growing under the Trees; but it was very thin. We saw no Trees that bore Fruit or Berries.

"We saw no sort of Animal, nor any track of Beast but once; and that seemed to be the tread of a Beast as big as a great Mastiff-Dog. Here are a few small Land-birds, but none bigger than a Blackbird: and but few Sea-fowls. Neither is the Sea very plentifully stored with Fish, unless you reckon the Manatee and Turtle as such. Of these creatures there is plenty; but they are extraordinary shy; though the Inhabitants cannot trouble them much, having neither Boats nor Iron.

"The Inhabitants of this Country are the miserablest People in the world."

The part explored was a large bay in which there are numerous islands, between sixteen degrees and seventeen degrees south latitude. A part of the adjacent mainland is now called Dampier Land, and the islands Buccaneer Archipelago; the latter doubtless in allusion to the fact that Dampier and his crew were really buccaneers. On his voyage in the *Roebuck*, in 1699, Dampier surveyed a long stretch of the coast, from Sharks' Bay, as he named it, northward. This is in about twenty-five degrees south latitude, where he found the country pretty and inviting, though there were no large trees. Arriving in August, "most of the trees and shrubs had either blossoms or berries on them. The blossoms of the different sorts of trees were of several colours, as red, white, yellow, etc., but mostly blue; and these generally smelt very sweet and fragrant, as did some also of the rest. There were also besides some plants, herbs, and tall flowers, and some very small flowers growing on the ground, that were sweet and beautiful, and for the most part unlike any I had seen elsewhere."

I will give only one more extract from Dampier. It shows how keenly alive he was to the beauties and utilities of the native flora. In about twenty-one degrees south latitude, on the western side of Australia, the reader will find an island named Rosemary Island. Concerning this island Dampier says: "There grow here two or three sorts of shrubs, one just like Rosemary; and therefore I called this Rosemary Island. It grew in great plenty here, but had no smell. Some of the other shrubs had blue and yellow flowers, and we found two sorts of grain like beans. The one grew on bushes; the other on a sort of creeping vine that runs along on the ground, having a blossom like a bean blossom, but much larger, and of a deep red colour, looking very beautiful." The last is *Clianthus Dampieri*.

Dampier brought home dried specimens (preserved at Oxford and in the British Museum) of some of the plants that struck him by their peculiarities, and, having a person on board skilled in drawing, he caused drawings to be made of a number of plants, birds, and animals, engravings of which were published in 1703, in the volume from which I have quoted.

Confining ourselves to the flowers, it is interesting to note that the figures are sufficiently accurate to enable one to identify most of them. But before giving an account of the firstfruits of Australian botany it may be well to give some particulars of the vegetation, and some comparisons of it with what we in the northern hemisphere, and more especially in the British Islands, are familiar with. In a country having an area of nearly three million square miles, stretching through forty degrees of longitude and twenty-

GLORY PEA. (Clianthus Dampieri Marginatus.)

Reproduced by kind permission of W. ROBINSON, ESQ.

eight degrees of latitude, from ten degrees to thirty-eight degrees south, and having mountains rising to a height of seven thousand feet in its southernmost or coldest part, very considerable diversity in the vegetation of widely-separated parts would be expected; and this is so, though what may be termed the characteristic features and components of the flora are sufficiently general for the object of these articles.

As compared with the flora of the British Islands, and even with that of the whole of Europe (which is about one-fifth larger than Australia), the flora of Australia is remarkable in a variety of ways. It is remarkable for the large number of species or kinds of trees and shrubs; for the large number of species of one and the same genus; for the large number of trees and shrubs having brilliantly coloured flowers and woody seed-vessels, associated with hard, grey-green or blue-green foliage; for the large proportion of species peculiar to the country; and for the large number of very local species.

The actual published number of species of flowering plants and ferns combined, native of Australia, is about nine thousand, of Europe about nine thousand five hundred, and of the British Islands about one thousand five hundred. It should be added that some botanists, who take a more limited view of what constitutes a species, would considerably augment the total number in each of the three areas named. It will be seen that the total number for Australia is not relatively high, but two things have to be taken into consideration: first, many parts have not even yet been thoroughly explored; and, secondly, there is a vast interior area supporting only the scantiest vegetation.

I will conclude my references to Dampier with a brief account of some of the few plants figured in his "Voyage to New Holland in 1699." Foremost among these plants is the brilliantly coloured parrot flower, glory pea, or Sturt's pea (*Clianthus Dampieri*) as it has been called. This is one of the most gorgeously beautiful plants of the great pea family, and is intimately associated with the progress of geographical discovery in Australia, having been collected not only by Dampier, but by Allan Cunningham, Captain Sturt, Ferdinand von Mueller, and other explorers, on various notable expeditions in different parts of the country. Though comparatively rare, it ranges all across Australia, from the Dampier Archipelago on the west, to the Lachlan and Darling rivers in New South Wales. The accompanying figure of it is about half natural size; the flowers being between four and five inches long, of a rich crimson-red, with a flashing purple black centre of a velvet-like texture. It has been cultivated in this country since 1858, and still exists in a few gardens; but it requires a skilful gardener to bring it to perfection. There is only one other species of the genus (*C. puniceus*), a native of New Zealand, where, however, it is exceedingly rare in a wild state, existing only in some small islands on the north-east coast of the northern island. It was discovered by Sir Joseph Banks and Dr. Solander on Captain Cook's first voyage. This is much more easily cultivated than the Australian species, and may often be seen in flower at Kew, where, in the North Gallery, paintings of both may be seen.

The plant mentioned by Dampier as resembling rosemary is also very widely spread, and at the same time exceedingly common in some districts, especially on the sandy sea-coasts. It is the *Olearia axillaris* of botanists, and extends all round the western and southern coasts, and is also found in Tasmania. Though externally resembling rosemary, it is closely related to our native golden rod. Among the other plants figured by Dampier is a species of the characteristic genus *Casuarina* (concerning which I shall have something more to say anon), *Dampiera incana*, *Diplolæna Dampieri*, *Isotoma petræa*, *Solanum orbiculatum*, and a species of *Melaleuca*. The chief interest attaching to these plants is their connection with the first explorer of Australia; therefore no further particulars of them need be given here.

Nothing further was learnt concerning Australia until about a century later, when Captain James Cook, after circumnavigating the equally unknown New Zealand Islands, proceeded westward and discovered the eastern coast of Australia, which he surveyed from Botany Bay northward. This was all accomplished in a barque of two hundred and seventy tons, but, for the size of his vessel, he had a numerous crew; and there was also a party of artists and naturalists, headed by the subsequently celebrated Sir Joseph Banks. Large collections of dried plants were made; the artists painted them in their fresh condition, and the botanists recorded and described all the plants that came under their observation. None of the artists survived the voyage, but Banks enjoyed a long and distinguished career; yet, strange to say, although he spent large sums in getting the drawings engraved and the descriptions completed, the engravings still lie unpublished in the British Museum. A few of the plants were published by contemporary botanists; but the bulk were described and published by the botanists of subsequent expeditions, English and foreign. Robert Brown, the *botanicorum facile princeps* of his time, who was botanist to Flinders's voyage to the *Terra Australis* (1801-1803), published a large number of them. In the meantime, as a result of Cook's surveys and Banks's recommendations, the first penal colony was established in New South Wales (1787), and Banks himself maintained collectors there to enrich the Royal Gardens at Kew. As the extracts from Dampier's narrative demonstrate, among the few trees that attracted his attention were some gum trees (*Eucalyptus*), which he called dragon trees, and likened to apple trees. Banks's first walk in New South Wales revealed to him the existence of trees which he rightly conjectured must belong to the same family, or genus, as those observed on the western side of the continent; but these early travellers did not at all realize the variety and value of them. This will be the subject of my next article.

Science Notes.

We have the pleasure of announcing that a new series of articles on English Medals, by Mr. G. F. Hill, M.A., will be commenced in our next issue, each contribution being accompanied by a full-page photographic plate.

At last a true process of photography in colours is announced. Although colouring media are employed, the result is a photograph in colours of nature. M. Villedieu-Chassagne, the inventor, takes a negative on a gelatine plate prepared by treatment with one of his solutions, the plate being developed in the ordinary way. A print is then taken on glass or paper, which, in either case, is prepared by the same solution, the transparency or the print as yet showing no trace of colour. It is then treated with blue, green, and red solutions; these colours, by their various combinations, imparting to the subject all its varieties of hue, by what is termed selective absorption. Sir H. Trueman Wood declined to be convinced by an inspection of M. Chassagne's results, and the latter was good enough to demonstrate the whole process for him in the laboratory of King's College. Our own countryman was not only convinced, but he himself photographed a bunch of flowers brought from Covent Garden, and also other test objects. Sir H. T. Wood says: "I cannot believe that any investi-

XUM

gation will throw doubt on its genuine character, for it was carried out under test conditions . . . the sole reservation being the nature of the materials employed." It will be seen that M. Chassagne employs four solutions—one for the purpose of rendering the plate or print susceptible to the other three coloured solutions—but the composition of the whole is, for the present, retained as a secret. Captain Abney, who was with Sir H. T. Wood, says: "I was present as a sceptic, and came away partially convinced . . . and I shall not be satisfied till I get the plates that have been promised me by the inventor, and taken negatives of certain test objects which will be unknown to the inventor."

Dr. Arthur Willey, who, two and a half years ago, left England for the South Seas in search of the eggs of the pearly nautilus—the only living representative of the great group of extinct animals whose shells are known as ammonites—has been rewarded with success. He has ascertained that these creatures are trapped in baskets by the natives of some of the Melanesian Islands and used as food. Last summer Dr. Willey, in Lifu, one of the Royalty Islands, captured the nautilus in three fathoms of water, and constructed a large submarine cage in which he kept specimens, feeding them daily. By December last some of the nautili had spawned in the cage. Each egg is as large as a grape, and is deposited separately by the mother nautilus. "It is," says Prof. Ray Lankester, "a legitimate source of gratification to British men of science that a successful result has followed from the application of these funds"—referring to the Balfour studentship and the Government grant fund of the Royal Society, by means of which the young naturalist referred to was enabled to carry out his investigations.

The late Sir B. W. Richardson is credited with the following curious information on suicides. The rate of suicides is highest in the last four days of June, and lowest in February; more common among Protestants than Roman Catholics, and rarest among the Jews. It increases with education, and spreads with railways and telegraphs. More men than women are swayed by its influence, and the average of suicides is set down at twelve in every one hundred thousand.

Obituary.

All ornithologists will hear with deep regret of the death of Herr Heinrich Gätke. Born in a small town of the Mark of Brandenburg, Heinrich Gätke went at an early age to the Island of Heligoland, resolving to pass a number of years immediately by the sea as a marine painter.

As is well known, the Island of Heligoland is without rival as a bird observatory. Throughout the year—scarcely ceasing for a day—tens of thousands of birds pass the island on migration.

It is not surprising, therefore, that Gätke the artist should have become Gätke the ornithologist, so well known by his book, "Heligoland as an Ornithological Observatory," which was the result of fifty years' experience on the island. Besides being an able thinker, Herr Gätke was a splendid observer and field naturalist, and he will be much missed by the ornithological world. It is indeed to be hoped that his important position as an observer on Heligoland will be filled without delay.

Thomas Gwyn Empey Elger, who died on the 9th January, aged fifty-nine, was a distinguished selenographer whose researches added much to our knowledge of the lunar surface. His early training as a draughtsman stood him in good stead in his efforts to depict the formations on our satellite. About thirty years ago he set up his first observatory in Caldwell Street, Bedford, and was elected a Fellow of the Royal Astronomical Society in 1871. On the founding of the British Astronomical Association, he was asked to take charge of the lunar section. An enduring monument of his achievements in the study of the moon is to be found in his book, "The Moon," published in 1895. Mr. Elger was also devoted, more or less, to other branches of science, for he was a leading spirit in many scientific enterprises in his own town, and also served as Mayor, on the Commission of the Peace, and on many committees where his experience was deemed valuable.

We regret also to record the death of Mr. Harry Proctor, youngest son of the late R. A. Proctor, whose name was for many years so closely associated with this magazine. He died on the 20th December last, after having recently attained his majority. The young man, like his father before him, betrayed a predilection for things scientific; but, unfortunately, constitutional weakness thwarted all serious efforts in this direction.

Notices of Books.

Journal of the Right Hon. Sir Joseph Banks, Bart., K.B., P.R.S. Edited by Sir Joseph D. Hooker. Pp. 466. With Portraits and Charts. (Macmillan.) 17s. In this age of multitudinous books, when the personal characteristics, foibles, and views of minor men are preserved in print more for the glorification of their families than on account of public interest, it seems astonishing that the journal kept by Sir Joseph Banks during Captain Cook's first voyage in H.M.S. *Endeavour*, in 1768-71, should have had to wait nearly one hundred and thirty years for publication. Yet that is so, and the story of why it is so is told by Sir Joseph Hooker. It is briefly this. When Sir J. Banks died without issue in 1820, his papers and correspondence, including the journal were left to the late Dr. Robert Brown, with the object of his writing a life of Banks. Age and infirmities prevented the realization of this project, and the materials were handed to Dr. Dawson Turner, F.R.S., who had the whole faithfully transcribed. In 1873 the originals and copies of the journal and correspondence were deposited in the British Museum; but they were claimed by Lord Brabourne some ten or eleven years ago, afterwards to be sold in two hundred and seven lots at Sotheby's for £182 19s.! For this beggarly sum (minus the auctioneer's commission) the noble Peer was willing to sacrifice all Banks' manuscripts and let them be scattered to the four corners of the earth. But for the copies taken when the journal and letters were in the possession of Dr. Dawson Turner, the present volume could not have existed. The action of Dr. Turner in having the manuscript transcribed thus saved the work from perishing, and for it naturalists cannot be too grateful. How much would have been lost to science had such forethought not been exercised can be seen in the volume now before us. The charming narrative, full of first impressions of a strange world and people; the activity of Banks as a collector and his acuteness as an observer; and the records of natural history, geography, hydrography, and ethnography obtained during this unique voyage—the pioneer journey of a naturalist around the world—combine to place the volume in the first rank of scientific classics.

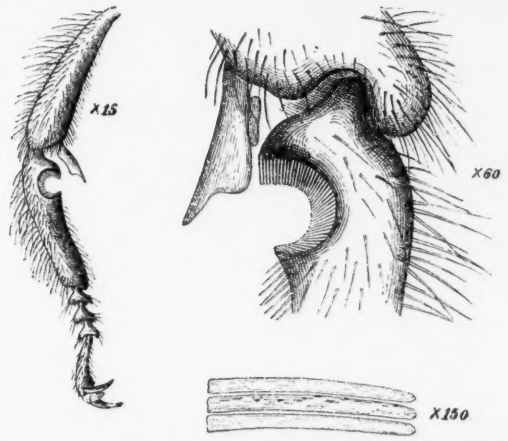
Few works could await publication for a century and a quarter and then be successful; but the present volume will find an even greater number of readers now than it

would have, had it appeared at the time it was written. The appearance of the volume under the editorship of Sir Joseph Hooker is most fortunate; for we venture to assert that had a ballot of naturalists been taken as to the best editor of the journal, the name of Sir J. Hooker would have headed the list.

It only remains to be said that an interesting biographical sketch of Banks, and one of Dr. Solander, who was his first librarian, and companion during Cook's voyage, form an introduction to the journal; and that the portraits of these investigators are excellently reproduced in two plates. There is also an alphabetical list, with biographical notes, of the earlier voyagers and naturalists to whom reference is made by Banks.

Handbook for the Bio-Chemical Laboratory. By Prof. John A. Mandel. (New York: John Wiley & Sons. London: Chapman & Hall.) 6s. 6d. Interest in this book is not limited to laboratories of physiological chemistry, but there the book will be found exceptionally serviceable. To have in a concise form directions for preparing the most important substances that enter into the composition of the fluids and tissues of the animal body, and more than two hundred tests for them, will greatly facilitate study, and save a large amount of time at present spent in finding descriptions of the processes in works of reference. Biologists and chemists alike will recognize the value of a *vade mecum* of this character.

Round the Year: a Series of Short Nature-Studies. By Prof. L. C. Miall, F.R.S. (Macmillan.) Illustrated. 5s. One might gather from the title of this book that it contains an account of what might be seen or found during each day or month in the year. Such, however, is not the scope of the book. As the author tells us in the preface, his book is a series of sketches suggested by the natural events of 1895. From the subjects which interested him from day to day he has selected those which admitted of popular treatment. His series of short discussions is thus



Fore Leg of Bee with Tibial Comb. The Comb more highly magnified. Three Teeth of the Comb.

eminently popular, and suited especially for young observers. The information is sound, and put in a way which both pleases and instructs. A chapter on "Animals with and without Combs" is especially good. The titles of a few other chapters will show the variety of topics discussed:—"Insects and Plants in Mid-Winter," "Snowflakes," "The Moon," "Catkins," and "The Love of Mountains."

Habit and Instinct. By C. Lloyd Morgan, F.G.S. Arnold.) 16s. Prof. Morgan is a well-known exponent of biological problems. In the book before us the author commences by lucidly explaining the difference between habit and instinct. He sums up his case briefly as follows:—"Instincts," he says, "are congenital, adaptive, and co-ordinated activities of relative complexity, and involving the behaviour of the organism as a whole; . . ." while habits "owe their definiteness to individual acquisition and the repetition of individual performance." The author then describes a number of very interesting experiments which he has lately conducted with young birds of different kinds hatched in an incubator. He goes on to draw conclusions from these experiments, and explains and discusses many of the great biological theories of the day in such an impartial and learned manner that the reader cannot fail to be instructed. Beyond this Prof. Morgan suggests several modifications of antagonistic theories, which will help, we sincerely hope, to bring together those great thinkers whose opposing views prevent them at present from combining forces and working on the same lines. The book may serve yet another purpose. Again and again the author deplores the want of more knowledge gained from direct observation and experiment. Let us hope that some readers of this book will be roused to take a practical part, however small, in the furthering of scientific knowledge. Whether the author's theories be accepted or not by those who are leaders amongst physiologists and psychologists, we do not hesitate heartily to recommend a study of them to all who are interested, ever so remotely, in the many fascinating problems connected with habit and instinct.

Notes for Chemical Students. By Dr. Peter T. Austen. (John Wiley & Sons, New York, 1896. Chapman & Hall, London.) We do not know whether to praise or condemn this little book. Its American garb and quaint phraseology interests and annoys the reader. It seems to be well up to date, and the author's views on matter and energy seem to be orthodox and clearly expressed, and he has not failed to borrow from kindred books illustrations and arguments which are useful to the chemical student. We object, however, to chlorin, chlorid, sulfat, and other phonetic spellings, and also to "chemism" for chemical attraction, especially when it is defined as a polar force. The author objects to the use of the word "bond," and suggests the term "valence," which has something to be said in its favour. On page 37 he, however, adds, "In my quiz classes I call it a 'val.' Thus oxygen has *three* vals." The italics are ours, but the meaning of the sentence we must leave to our readers. Atomic movements are described on page 41 as "a vast snarl of motions," and a chapter on "rests," to our surprise, was devoted to a consideration of "radicals."

Rheumatism: its Nature, its Pathology, and its Successful Treatment. By T. J. Maclagan, M.D. Second Edition, pp. 324. (A. & C. Black.) 10s. 6d. The last twenty years has seen the introduction of many means of alleviating human suffering, but no malady has been more successfully softened than has acute rheumatism, or rheumatic fever, by the use of salicyl compounds. When Dr. Maclagan introduced salicin to the notice of the medical profession in 1876, acute rheumatism was the despair of physicians. Let the words of the late Dr. Wilson Fox state the position to-day. "I never see acute rheumatism now," he wrote to the author; "as soon as a case is admitted to hospital, the house physician gives him salicin or salicylate of soda, and he is cured before I see him." Of the thirty or forty salicyl compounds known, only these two are used in practice as anti-rheumatic agents, and preference is given to salicin. The mode of

XUM

action of this wonderful subduer of agonising pain, and the whole subject of the pathogenesis of rheumatism, is expounded in the volume under notice. Primarily, the book is of interest to medical students and practitioners, but there is a lot of readable matter in it upon the cause and nature of rheumatic troubles.

Elementary Practical Physiology and Histology. By M. Foster, F.R.S., and J. N. Langley, F.R.S. (Macmillan & Co., London, 1896.) A very few words suffices in drawing attention to a new edition of this well-known practical guide to physiology and histology. Prof. Michael Foster is too well known to require any arguments from a reviewer on the merits of his book. It is now twenty years since the first edition was published, and thousands of students in all parts of the world must have appreciated the accuracy of the instruction and minutiæ of detail which the authors have embodied in their text-book. The present edition contains many additions which increase its value.

Life in Ponds and Streams. By W. Furneaux, F.R.G.S. (Longmans.) Illustrated. 12s. 6d. This is one of the "Out-Door World" series for young naturalists, and forms a companion volume to Mr. Hudson's book on British birds, which was reviewed in our columns a short time ago. The collecting and studying of life in ponds and streams are specially adapted to the young naturalist. Every ditch is teeming with varied and interesting creatures which can easily be obtained, and the study of these creatures is open to everyone to a certain extent, even without the aid of a microscope. Mr. Furneaux goes fully into the subject. He gives sound and practical advice to the would-be collector and student, telling him how and where to obtain the different species, and how to preserve and study them whether alive or dead. A great number of the species of protozoa, worms, leeches, molluscs, crustaceans, spiders, fish, insects, and amphibians, which can be found in this country, are described, and their haunts and habits depicted. The illustrations are numerous and, on the whole, excellent, and altogether the volume forms a good first guide to the study of pond-life.

Elementary Geology. By G. S. Boulger, F.L.S., F.G.S. (Collins.) Illustrated. 1s. 6d. A text-book which has circulated to the extent of thirty-six thousand copies may fairly be regarded as having met a want, but it does not necessarily follow that a book designed for the requirements of the early days of the Science and Art Department is still a desideratum, even when "well brought down to date," as Mr. Boulger, the reviser of Mr. Davis' well-known little text-book, says in his preface. The work still bears, to a great extent, its original features, and the limited space of one hundred and sixty pages, in these days, is altogether inadequate to deal with the ever-expanding subject of geology. Twenty years ago, when concise handbooks on geology at a low price were not available, there was some excuse for this sort of thing; but an all-round advance since that time demands something more in keeping with the spirit of enterprise and progress which now obtains.

Problems of Biology. By George Sandeman, M.A. Pp. 213. (Swan Sonnenschein & Co.) 6s. Science is now so highly specialized that it is difficult for a worker in one branch to understand the significance of the facts accumulated in another; and the result is the enunciation of theory upon theory, which, though able to fully account for a set of observations made from one particular aspect, entirely fails when applied to more extended views. The author of this book expresses this separation very neatly in the following words, with which we are in entire agreement: "The outstanding evil is that every science suffers from an insular ignorance of what is meant by the others; philosophy, for instance, at present knows little of animals and plants but what it has learned through the biology of hypothesis, and accepts the results of the latter for observation; and biology is content to find the true differences of organisms in the structure of small particles within them, through an inadequate knowledge of physics. In a word, one science is only too ready to accept the abstractions of others as answering to the nature of the matter studied" (p. 13). Many statements of like character will be found in other parts of the book, and they will be especially appreciated by students of synthetic philosophy. What Mr. Sandeman aims at in his essay is to define the right method and the limits of biology, and thence to derive a criterion wherewith biological theories may be judged. His work is thus a contribution to the philosophy of nature, and an attempt to supplement and interpret biological theory by a critical method, and as such it is commendable. To him, biology is not a mere encyclopædia of facts about organisms—not a science of form or of function, but the science of the union of these aspects. He scouts the idea that science and philosophy are independent, and goes so far as to remark: "The problem of philosophy as regards organisms is the problem of biology." This aphorism, indeed, may be regarded as the metaphysical mirror to which the author holds up the hypotheses of Stahl, Darwin, Weismann and Naegeli, de Vries, Galton, Spencer, and Roux, and which reveals their deficiencies.

SHORT NOTICES.

The Elements of Physics. By Edward L. Nichols and Wm. S. Franklin. (Macmillan.) Illustrated. 6s. This work, in the complete form, consists of three volumes, the one before us being Vol. II., which deals with magnetism and electricity. It is purely a students' book, and, sooth to say, profitable only to those who do not quail before a vast array of mathematical formulæ of the higher order. To those, however, who can infuse life into such dry bones, the book will be welcome, for the enunciations are clear, the reasoning close and well sustained, and the deductions logical and convincing.

Structural Botany. Part II.—Flowerless Plants. By Dunkinfield Henry Scott, Ph.D., F.R.S. (A. & C. Black.) Illustrated. 3s. 6d. Unless one studies living plants in the field, and follows up the study with practical work in the laboratory, all attempts at learning botany are of but little real value. The needful appliances for practical work are not expensive, and a very simple outfit will serve for any student to thoroughly confirm all Dr. Scott advances in this essentially practical handbook. Out of the immense variety of cryptograms some twenty-three types have here been selected, and the morphological treatment is such as to invest the whole with an admirable continuity which imparts a connected idea of the great groups of plants. The author has, as far as possible, followed a descending order, proceeding from the complex to the simpler plants, beginning with *Selaginella* and ending with the *Myxomycetes*. While the book, as a whole, is good, the illustrations are excellent as mediums for elucidating the points intended.

The Biological Problem of To-Day. By Dr. Oscar Hertwig. Translated by P. Chalmers Mitchell, M.A. (Heinemann.) Illustrated. 3s. 6d. Preformation or epigenesis? This, it would appear, is the problem of to-day as far as Dr. Hertwig's book is concerned, and hence we find here an attempt to explain that exceedingly complicated process—the way in which the fertilized egg-cell gives rise to the adult organism. That the highly-developed types of animal and vegetable life have a very lowly origin we do know; but as to the nature of the inherent forces—if we may so express it—in the simple cell, which govern, as it were, the behaviour of the cleavage cells in the formation of the organs of embryos, we can do little more than offer a little intelligent speculation. However, it is something to be able to say to those interested in the problem that here is a book which sets forth in intelligible terms a well-reasoned account of the possible process of organic development. Nevertheless, as one reads this book, it is clear that the evolutionist, as he applies his intellectual powers to the study of the so called *germplasm*, is practically at the end of a blind alley; he may throw much intellectual light on the structure, but when that structure is an opaque wall it is something more than difficult to see through it after all.

Fuel and Refractory Materials. By A. Humboldt Sexton, F.I.C., F.C.S. (Blackie & Son.) Illustrated. 5s. A book that fills a void is a desideratum, and in this connection we are indebted to Prof. Sexton. Such exhaustive treatises as those of Dr. Percy and Dr. Mills, and the scrappy bits disposed here, there, and everywhere in manuals of metallurgy, form two extremes which don't exactly suit the student who is seeking the shortest route to a comprehensive knowledge of fuel. Hence, Prof. Sexton jumps into the breach, and supplies, in a convenient form, all that even advanced students of metallurgy, engineering, etc., need know on this important subject. Solid, liquid, and gaseous fuels; furnaces for metallurgical purposes; pyrometry; calorimetry; testing of fuels; heating power of fuels, etc., etc., are all treated in the same straightforward way—always inclining towards the utilitarian aspect—and yet there is plenty of evidence which clearly indicates that the work has been rapidly, and, perhaps, a little carelessly, compiled.

Physics Note Book. By J. C. P. Adolphus. (Macmillan.) 2s. 6d. Apparently this book is intended for naval officers, and aims at expediting practical work in the laboratory. Notes, formulæ, and instructions for experiments are given, and space is left for sketches and diagrams of apparatus, which the student is advised to make from his own observations. The plan of the book will, it strikes us, serve two useful purposes, namely, the elimination of a good deal of writing in the laboratory, the time saved being available for actual experiment; and, second, the necessary formulæ being given, time is again economized by obviating the irksome task of too frequent reference to books.

Modern Optical Instruments, and their Construction. By Henry Orford. (Whittaker & Co.) Illustrated. The title of this book scarcely gives a just idea of its contents, for its main subject is the human eye, which, though certainly an "optical instrument," is not distinctively "modern." But, considered as a treatise on the eye, the book may be recommended as giving a clear exposition of its nature as an optical instrument, of the defects to which it is liable, and of the modes in which those defects are discovered and corrected. In the main, Mr. Orford's descriptions are easily followed, for the book contains an unusually large number of diagrams, which, though poor as to drawing, are at least clear and simple. The literary construction is faulty at times, and in one case at least the sequence of the articles is open to objection, for Chapters XII. and XIII., which deal very briefly with the optical lantern and the stereoscope, are preceded by one on stereoscopic projection, which should surely have followed them. All three chapters are, however, too brief to be of any real value, and the few lines given on the spectroscope would have been better omitted.

British Patent Law, and Patentees' Wrongs and Rights. By Hubert Haes. (Whittingham & Co.) 1s. 4d. Inventors, as a rule, are comparatively ignorant of the laws relating to patents, and so, generally, commit the fruits of their genius to the safe keeping of a patent agent, who, in many ways, may serve his client with apparent fidelity, while in reality he serves himself a great deal more. A book such as this indicates the many pitfalls, methods of pirating, and other ways in which an inventor may himself remain poor while others are reaping the advantages of his innovations, and on this account it can be recommended to all those who have anything worth protecting by letters patent.

We have received from Mr. Ouseley a little pamphlet entitled, *Era of Light: a Universal Calendar for All Time, or Perpetual Almanac.* The year, according to the proposed innovation, consists of three hundred and sixty-four days, each quarter having ninety-one days, or thirteen weeks exactly. By introducing an extra Saturday at the end of each year, and two extra Saturdays every fourth year, the odd days are conveniently disposed of so as to make the days of the week fall on the same date every year, and the odd minutes and seconds are at suitable intervals similarly eliminated, so that the same sequence will obtain, with less than one day's error, in a period extending over three hundred and sixty thousand years.

Messrs. Horne and Thornthwaite have put upon the market Overstall's patent driving clock, a piece of apparatus suited for equatorial telescopes. It has, however, been designed principally for small telescopes, mounted either on a tripod stand or on the usual pedestal, and it involves but a small outlay, so that amateurs with limited means may enjoy the advantages of a hitherto inaccessible auxiliary, chiefly through the prohibitive cost of the ordinary driving clock. The right ascension circle is driven round by a simple weight (about three or four pounds), which directly actuates a screw or worm gearing with the toothed rim of the right ascension circle, and an adjustable weight serves to balance instruments of various sizes. Such an arrangement brings within the reach of the amateur a vast field of useful investigation, for, with the aid of the simple camera and spectroscope, celestial photography can be studied with reasonable hope of doing something of more than passing interest, even with a telescope of no more than three inches aperture.

BOOKS RECEIVED.

The Collector's Manual of British Land and Freshwater Shells. Second Edition. By Lionel Ernest Adams, B.A. (Taylor Bros., Leeds.) Illustrated.

Ireland. Edited by R. Barry O'Brien. (Unwin.) Map. 2s. 6d.

Formation Méchanique du Système du Monde. Par L'Abbé Th. Moreux. (Ganthier-Villars et Fils, Paris.) Illustrated.

Elementary Botany. By W. Bland. (Bemrose.) Illustrated. 1s.

The Survival of the Unlike. By L. H. Bailey. (Macmillan.) Illustrated. 8s. 6d.

Histoire Naturelle de la France. (*Minéralogie.*) By Paul Gaubert. (Deyrolle, Paris.) Illustrated. 5 fr.

Heavy Trial Balances Made Easy. By J. G. Craggs, F.C.A. (Scientific Press.) Illustrated. 2s. 6d.

The Photographer's Exposure Book. By F. W. Mills. (Dawbarn & Ward.) 1s. net.

Stenopaic or Pinhole Photography. Second Edition. By F. W. Mills and A. C. Ponton. (Dawbarn & Ward.) Illustrated. 1s. 6d. net.

Exterior and Interior Photography. By F. W. Mills. (Dawbarn & Ward.) Illustrated. 3s. net.

A Dictionary of Birds. By Alfred Newton, assisted by Hans Gadow. (A. & C. Black.) Illustrated. 30s. net.

Pioneers of Evolution, from Thales to Huxley. By Edward Clodd. (Grant Richards.) Illustrated. 5s. net.

The Coasts of Devon and Lundy Island. By John Lloyd Warden Page. (Horace Cox.) Illustrated. 7s. 6d.

British Rainfall, 1895. Compiled by G. J. Symons, F.R.S. (Stanford.) Illustrated. 10s.

Sunshine and Storm in Rhodesia. By F. C. Selous. (Rowland Ward & Co.) Illustrated.

The Art of Wildfowling. By Abel Chapman, F.Z.S. (Horace Cox.) Illustrated. 10s. 6d.

Microscopic Researches in the Formative Property of Glycogen. Part I.—Physiological. By Chas. Creighton, M.D. (A. & C. Black.) Coloured Plates. 7s. 6d. net.

Our Weights and Measures. By H. J. Chaney. (Eyre & Spottiswoode.) Illustrated. 7s. 6d.

Modern Dogs.—Terriers. By Rawdon B. Lee. (Horace Cox.) Illustrated. 10s. 6d.

In New South Africa: Travels in the Transvaal and Rhodesia. By H. Lincoln Tangye. (Horace Cox.) Illustrated. 10s. 6d.

The Law relating to Motor Cars. By H. Langford Lewis and W. Haldane Porter. (Butterworth & Co.) 3s.

Healthy Dwellings. By Sir Douglas Galton, K.C.B., F.R.S. (Clarendon Press.) Illustrated. 10s. 6d.

Outline of Psychology. By Edward Bradford Titchener. (Macmillan.) Illustrated. 6s. 6d. net.

Advanced Mechanics. Vol. II.—Statics. By W. Briggs, M.A., and G. H. Bryan, F.R.S. (Clive.) Illustrated. 3s. 6d.

What to do in Cases of Poisoning. Eighth Edition. By Wm. Murrell, M.D. (Lewis.) 3s. 6d.

Disease and Defective House Sanitation. By W. H. Corfield, M.D. (Lewis.) Illustrated. 2s.

Fruit Culture for Amateurs. By S. T. Wright. (L. Upcott Gill.) Illustrated. 3s. 6d.

Italian Highways. By E. Augusta King. (Bentley.) Illustrated.

Diseases of Plants induced by Cryptogamic Parasites. By Dr. Karl Freiherr von Tubeuf. English Edition by Wm. G. Smith, Ph.D. (Longmans.) Illustrated. 18s. net.

Our Place among Infinities. By Richard A. Proctor. New Edition. (Longmans.) 3s. 6d.

A Handbook to the Order Lepidoptera. Allen's Naturalists' Library, Vol. III. By W. F. Kirby, F.L.S. (Allen & Co.) Illustrated.

Everybody's Guide to Photography. By "Operator." (Saxon & Co.) Illustrated. 6d.

The Story of the Weather. By G. F. Chambers. (Newnes.) Illustrated. 1s.

Matriculation Directory, No. XXI. January, 1897. (Clive.) 1s.

Flowering Plants and Ferns. Two vols. By J. C. Wilis, M.A. (University Press.) Illustrated. 10s. 6d.

Star Atlas, with Explanatory Text. By Winslow Upton, A.M. (Ginn & Co.) 8s. 6d.

Smithsonian Report, 1894. S. P. Langley. (Government Printing Office, Washington.) Illustrated.

Mountain Observations in America and Europe. By Edw. S. Holden. (Smithsonian Institute.) Illustrated.

Proceedings of the Academy of Natural Sciences of Philadelphia, 1896. Edited by E. J. Nolan. (Logan Square, Philadelphia.) Illustrated.

Is Natural Selection the Creator of Species? By Duncan Graham. (Digby, Long, & Co.) 6s.

XUM

Letters.

[The Editors do not hold themselves responsible for the opinions or statements of correspondents.]

THE LEAF-CUTTER BEE.

To the Editors of Knowledge.

Sirs,—It is gratifying to me to know that my letter in January Knowledge under the above title has amused Mr. Duncan. I hope the following stubborn facts will add to his amusement.

According to Mr. Duncan's letter in February Knowledge I am "incorrect," "inaccurate," "most misleading," and "distinctly incorrect." My authority is challenged, as well as the quality of the "pudding"!

Now, I reply to this letter with great pleasure. The awkward fact that I have for the past thirty years been in the habit of keeping a diary of facts observed (generally over three thousand per annum), enables me to do so with ease and comfort.

1st.—I ought to have written "the leaf-cutter bee *generally* selects a rose-bush of the 'tea' type." If Mr. Duncan has a Gloire de Dijon and Maréchal Niel growing near to each other, I think the bee would prefer the latter. At some future time I intend to give a complete list of plants and shrubs from which I have seen the leaf-cutter bees cutting the leaves.

2nd.—*I have seen* this bee start a burrow.

3rd.—*I have seen* the first piece of (circular) leaf taken down the burrow.

4th.—*I have seen* the first piece fixed at the bottom.

5th.—*I have seen* the formation of many cells.

6th.—*I have seen* the thin edge of the wedge-shaped piece put into the saucer-shaped foundation.

7th.—What I assert I assert on my own authority, from my own personal observations.

Perhaps the accompanying photograph, which I made

Photograph of Pieces of Rose Leaves forming one Cell of *Megachile willughbiella*. 1. Foundation of cell. 2. Cocoon containing larva. 3. Twelve circular pieces as covers, and the last one forming the foundation of the second cell.

three years ago, of the pieces (twenty-nine in number) forming one cell, will afford Mr. Duncan more "amusement."

The statement that the "pudding" was "a dark compact mass, emitting a fœtid odour," proves that Mr. Duncan was not present when it was being mixed, so he had no chance of trying the quality of a fresh one.

I do not rely upon every observation made by "well-known scientific men," many of whom copy the observations of their predecessors without testing their accuracy. Abundant proof of this can be given.

I should be very sorry to write that anyone was "distinctly incorrect," etc., unless I was able to give chapter and verse for such correction.

My object has always been to endeavour to show to others some of the marvels of insect life which I have been privileged to observe. Fred. Enock.

STAR SYSTEMS.

To the Editors of Knowledge.

Sirs,—My object in my letter on star systems was to show that a close correspondence in the proper motions of heavenly bodies which are situated at immense distances from each other affords no proof of physical connection, even when the resembling motions are of a very unusual character; while as regards the stars in the Plough, the correspondence has not been shown to be very close, nor are the proper motions of any unusual character. I do not think the parallax of any of these stars has been ascertained with any approach to certainty. But it is undoubtedly small; and as Sirius and Procyon are both comparatively near stars, it is not improbable that the actual distance between them is less than that between the extremes in the supposed system in Ursa Major. Physical connection does not, of course, imply common proper motion. Indeed, if one star is moving round the other in a very elongated ellipse, they may be apparently moving in opposite directions. But the converse question, whether common proper motion implies physical connection, is the one with which I was dealing. It does so, I think, only on certain conditions, viz., that the stars are situated within a moderate distance of each other, that the correspondence in their motions is close, and that the motions themselves are of such a character that only a small proportion of them can be ascribed to errors of observation. The stars in the Plough do not seem to me to fulfil any of these conditions. W. H. S. Monck.

SUNSPOTS.

To the Editors of Knowledge.

Sirs,—I wish to know, on good authority, the exact size of the sunspot that I am now watching, and which has been on the sun's face (to my knowledge) since January 25th. Can any reader of Knowledge oblige?

15th February, 1897. C. T. Hudson, F.R.S.

[We have seen the sun to-day! Mr. Hudson's spot is visible, but considerably diminished from what it was on January 25th. The group consists mainly of an approximately circular spot nearly three degrees of solar longitude in diameter, or twenty-one thousand four hundred miles. Area, three hundred and sixty millions of square miles. At various distances from the main spot are several smaller spots; total area, eighty millions of square miles. Extreme length of *group*, fifty-six thousand miles.—E. W. Maunder.]

VARIABLE STARS.

To the Editors of Knowledge.

Sirs,—The computed maximum of *o* Ceti, Mira, following the old terms, fell on November 3rd, 1896, and it again failed of verification.

But computing from the first observed maximum of last season, January 19th, that phase at the passing apparition should occur on December 17th, 1896, allowing the period 331·6 days to remain constant.

Beginning a search on September 1st, the star was not found with the field-glass until September 28th, and on the third night following it was lost. In ten days it was found, and then lost for another decade. The failures to find Mira may not unreasonably be attributed to fluctuations in light, and I would not say to the contrary. But in the light of experience it seems better to say that they were due to differences in the condition of the atmosphere—conditions not readily perceived under ordinary circumstances—for, as a result of my experience, I have a growing belief that, from exact measurements of the light of stars, an observer in the north-east quadrant can predict the formation of a cyclonic disturbance of the atmosphere in the south-west at a distance of over five hundred miles, and indicate its probable intensity and pathway.

My observations and estimates of the light of Mira for the passing epoch are as follows:—

1896.			Mag.
September	28	... ...	8·8
October	6	... ...	8·7
,,	16	... ...	8·5
,,	26	... ...	8·0
,,	28	... ...	7·9
,,	29	... ...	7·8
,,	30	... ...	7·8
November	1	... ...	7·6
,,	2	... ...	7·5
,,	5	... ...	7·2
,,	7	... ...	7·0
,,	8	... ...	7·00
,,	10	... ...	6·8
,,	12	... ...	6·7
,,	13	... ...	6·4
,,	14	... ...	6·2
,,	15	... ...	6·2
,,	16	... ...	6·00
,,	17	... ...	5·9
,,	18	... ...	5·7
,,	20	... ...	5·5
,,	23	... ...	5·3
,,	24	... Very red	5·1
,,	25	... ...	5·2

1896.			Mag.
November	28	... ...	4·9
,,	30	... ...	4·7
December	1	... ...	4·6
,,	3	... ...	4·6
,,	4	... ...	4·5
,,	5	... ...	4·5
,,	9	... Very red	4·4
,,	11	... ...	4·2
,,	13	... ...	4·2
,,	15	... ...	4·4
,,	19	... ...	4·2
,,	20	... ...	4·2
,,	22	... ...	4·2
,,	23	... Very red	4·4
,,	23	... ,,	4·2
,,	25	... ...	4·4
,,	26	... ...	4·3
,,	26	... ...	4·5
,,	27	... ...	4·3
,,	29	... ...	4·3
,,	30	... ...	4·3
1897.			
January	4	... ...	4·4
,,	5	... ...	4·1

By placing the maximum on December 16th, the period of 331·6 days remains unchanged; but it has been a question in my mind whether it has not been lengthened about twenty days. The star has been quite perplexing since December 15th. The figures which I give for any date are usually the result of three or four observations on that night, and on many of the nights since then I thought it varied as much as three steps. And last night it seemed to be on a rise for another maximum.

Comparison stars used:—

	Mag.		Mag.
N *s.f.*	8·2	66 Ceti	5·65
H *n.p.*	7·9	Nu ,, ...	5·2
71 Ceti	6·65	Xi^1 ,, ...	4·7
D ,, ...	6·62	Xi^2 ,, ...	4·5
75 ,, ...	5·75	Delta Ceti	4·2
70 ,, ...	5·62	a Piscium	3·9

R Leonis this season is a morning star, but for nearly three months the evenings have been more favourable for observations. Following the old terms, the maximum of this star was due on December 29th, 1896, but, as in years past, it came over forty days earlier.

My observations and estimates are as follows:—

1896.			Mag.
October	12	... ...	7·9
,,	13	... ...	7·8
,,	16	... ...	7·7
November	2	... ...	6·8
,,	6	... ...	7·1
,,	8	... ...	6·9
,,	13	... ...	6·8
,,	14	... ...	6·7
,,	16	... ...	6·7
,,	18	... ...	6·7
,,	19	... ...	6·7
,,	29	... ...	6·8
,,	30	... ...	7·00

1896.			Mag.
December	1	... ...	7·0
,,	2	... ...	6·7
,,	3	... ...	6·9
,,	4	... ...	6·9
,,	6	... ...	7·1
,,	9	... ...	7·1
,,	10	... ...	7·1
,,	11	... ...	7·2
,,	14	... ...	7·2
,,	15	... ...	7·2
,,	16	... ...	7·3
,,	27	... ...	7·6
,,	28	... ...	7·7

Taking Mr. Yendell's maximum of January 12th, 1896, or my own two days earlier, the maximum of the present apparition may be placed at November 15th, and the period of 312·87 days is maintained fairly well.

The comparison stars were:—

	Mag.		Mag.
Nu Leonis	5·3	d, *n.f.*	6·9
18 ,, ...	5·7	e, *s.f.*	7·2
c, just north of R ...	6·5		

There is no probability of another rise of this star this season.

The "Companion" has, apparently, made a correction for the future maxima of these variables of about forty days each, but its sufficiency and permanency is somewhat doubtful.

David Flanery.

Memphis, Tenn., 6th January, 1897.

LIFE-HISTORY OF THE COMMON TIGER BEETLE.

By Fred. Enock, F.L.S., F.E.S.

ACCORDING to certain authors, the number of named insects in the world is something like three hundred thousand! At first sight this seems a large number, but anyone by making a visit to the Insect Room at South Kensington Natural History Museum can see with his own eyes that this is a fact. The late Prof. Riley computed the number of insects in the world to be ten millions! while others consider this to be considerably below the number. Such numbers are simply beyond our conception, and many people turn away at the very idea of so many "horrible creatures." I am inclined to think it possible to clear away much of this prejudice, by the simple operation of truthfully depicting with pen and pencil the complete life-history of one of the commonest of British beetles. But the true life-history of an insect is not (as so many imagine) to be discovered in a few months or years. The chain may be almost complete, but still wants one or two links before the cycle is absolutely perfect, and years may pass by before the desired facts are observed; but—"perseverance overcometh all things."

My earliest recollections of the tiger beetle (*Cicindela campestris*) go back to my schoolboy days (some forty years ago), when I, on every occasion of a walk, was in the habit of poking my nose into every corner in which an insect might have taken refuge. On warm, bright days in April and May we used to start these beetles up from the sandy commons, and year after year this beautiful insect has been looked for at the return of spring. It is known to all collectors, and the first to attract the attention when seen in a drawer—for it heads the order *Coleoptera*. It is about half an inch long—the wing cases of a beautiful green colour, each with five irregular shaped spots, which are more or less yellow; the head golden green, tinged with crimson, as also are the antennæ, legs, and elytra. The mandibles are powerful and sharply toothed, giving the creature a most formidable appearance, well sustained by its ferocious nature, from which it takes its name of tiger beetle (Fig. 1). It is always ready and willing to show its teeth and to use them, the act of closing (on your finger) being accompanied by the gratuitous gift of a tiny drop of pleasant perfume.

The colour and markings bear a protective resemblance to its environment, for when the beetle is seated upon a clump of green moss it is most difficult to detect. It is the habit of the beetle to be always on the alert, and it invariably sees one coming, and starts up two or three yards in advance, quickly pitching down again on to the moss or short grass. The way to obtain it is to keep the eyes fixed two or more yards ahead, but quick eyes and hands are necessary to capture.

The actual life of the tiger beetle lasts but a week or two above ground, for after mating the male soon dies, while the female follows as soon as she has completed her task of depositing her eggs one by one in tiny burrows in the sand. This first stage (the egg) is frequently the last fact to be discovered by the naturalist, as the ingenuity of insects is so great that they are able in many cases to utterly baffle our attempts made year after year to find the nidus. The tiger beetle generally selects a bare, sandy piece of ground, well exposed to the south-west, sometimes on the level, at others the vertical side of a bank is chosen, wherein to deposit the eggs; each of which is most carefully placed. Raising her head and antennæ, she depresses

her abdomen until the tip touches the ground; next, the points at the end of the ovipositor are brought together so as to form one, which is driven into the sand, worked from side to side, and withdrawn, bringing with it a small amount of sand. It is again extended, and the trowel-shaped organs at each side of the tip are pressed deeper into the sand, until the hole is three-sixteenths of an inch deep by one-sixteenth diameter; the ovipositor is then carefully withdrawn, leaving the hole quite clear of loose sand. It is

Fig. 1.—The Tiger Beetle (*Cicindela campestris*).

again lowered to the full length, and an oval-shaped and smooth egg, one-fiftieth of an inch long, is extruded and placed at the bottom of the hole—"head up"; a few largish grains of sand are put in, and the hole so artfully concealed that few there be who find it. The beetle immediately makes another burrow, frequently within half an inch of the first, another egg is laid; and so on until quite a little colony is formed within a square foot. Each female lays a large number of eggs, which hatch in a few days into veritable little "tigers" of ferocity.

During my sojourn at Woking I had fine opportunities for studying these larvæ, my first acquaintance with which I made one bright day in May, when crossing over a part of the common. My eyes were arrested by the sudden appearance of a number of holes in the ground; their appearance was so sudden that I immediately pulled up and stood perfectly still, when in a few minutes each hole was filled up almost level—with something whose exact nature I could not at once decide. I moved forward a few inches, when every hole became empty—the "something" had shot down out of sight. Once more they filled up, and then I saw that it was a strange-looking head of some insect. Drawing from my pocket a long, narrow "fern spud," I drew my arm well back, and waited for the head to reappear. On it coming up and settling down with open jaws, I suddenly lunged out with my spud, intending to strike across the vertical hole and cut off the retreat of the creature. In this I was more than successful, for I managed to cut off its head, while the tail went on behind. I next tried to dig some larvæ up, and, after a good deal of trouble, managed to turn one fine one out upon the sand (Fig. 2).

Accustomed as I had become to all sorts of larvæ, I must confess that never before had I seen such a strange-looking one. It had an immense head, which appeared altogether too large for the chin, which was produced into an enormous size. The forehead was sloping upwards to the crown, which was overlapped by a large chitinous, semicircular, thoracic plate, followed by two smaller ones. The eyes were very small and cunning-looking, three in number on each side of the head. The most striking feature was the pair of curved and turned-up mandibles, which resembled a pair of tusks or cow's horns. The movement of these was exactly opposite to those of an ordinary larva, whose mandibles close ventrally, whereas those of the tiger beetle larva closed dorsally. Future examination showed to me the marvellous adaptability of these organs to the changed surroundings and life of the larva. The mature beetle runs after—and if necessary flies after—its prey, which is seized between the mandibles, which open and close beneath the head; but in the larva this is reversed and the prey seized by the mandibles opening above the mouth. The legs of the larva were long and sprawling, the toes bifid, long, and pointed; the abdominal segments flaccid and white, each with a brown dorsal patch and tubercles on each side and back, surmounted by long and short spines. The fifth abdominal segment caught my eye, for I saw that it was produced dorsally into a huge hump, having at the apex two short but powerful spines, with another pair in front, the bases of which were close to those on the apex; these were long and curved towards the centre, the hooked points sharp and drooping towards the fourth segment. The larva was capable of raising these long spines until they stood out wide apart, with the hooked points almost at right angles to the abdomen, and if pressed against any soft sand they would immediately penetrate it. I saw at a glance that this complex segment was intended to play some very important part in the economy of the larva. The anal segment was also armed with quite a brush of stiff spines, which I concluded were intended to assist the larva in walking. Happening to touch the tail, the larva immediately turned its head and thorax right over its back, and seized that part between its mandibles; then, after a moment's pause, it let go and sprang to a distance of twelve inches. I saw that in doing this trick it had immense mobility of the neck and thoracic segments. After I had thoroughly examined these movements I let it go.

Determined to see what went on below ground, I adopted

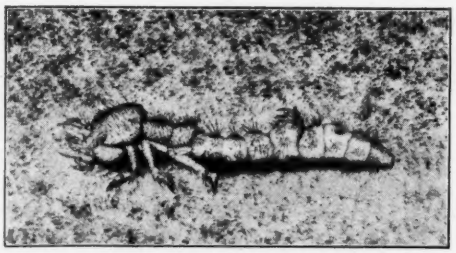


Fig. 2.—Larva.

my old plan used when watching the subterranean work of *Atypus piceus*—the British representative of trapdoor spiders. This was to obtain some plain glass jars of the type used by confectioners; these I filled with damp sand to within an inch and a half of the top, then taking a piece of cane a quarter of an inch in diameter, I carefully made a hole three inches deep, close to the side of the glass, which enabled me to see all that was going on. I next turned into this hole a larva which was nearly full-fed—about an

inch and a quarter long. At first it examined the artificial burrow, and evidently did not fancy living there with one side transparent, so it deliberately descended to the bottom and took up a mouthful of damp sand, which it plastered over the glass. This act was repeated a number of times until the larva had covered in a height of an inch and a half. I removed the sand and larva from the glass, refilled and renewed the hole at the side, and once more replaced the larva; and it once more, and many more times, plastered the glass, until at last it resigned itself to circumstances and became accustomed to my magnifier.

I found that it used its mandibles for excavating. Taking up a mouthful of sand, it turned its head up and fixed the sand above until a small load had collected; this was rammed up by the head, as the larva crawled up the hole, until the surface was reached, when the sand was balanced on the mandibles and front of the head, which was then jerked backwards with a sudden movement, and the sand sent flying to a distance of ten or twelve inches. When deepening its hole various impedimenta are met with—tiny pebbles of quartz, each of which is brought up between the mandibles, balanced, and shot away, and frequently as not rolls down the burrow of a neighbouring larva, which brings it up to the top, and in its turn throws it away from its door. When all such impedimenta had been removed, and the hole nicely smoothed, the larva would ascend to the top, and, raising its head above the surface, commence to bite mouthfuls of sand from around the edge until a rough enlargement had been made; then, raising its head well above, it hammered with its swollen chin into this until a perfectly smooth concavity had been formed all round, the exact curve of the chin. It was astonishing with what force the blows were given.

As soon as the pitfall was completed the larva rested from its labours by placing the head and first semicircular thoracic plate almost level with the top of the hole, in which the plate and head exactly fitted, the open and turned-up mandibles resting in the curved sides of the pitfall—ready to close at a moment's notice should any insect chance to stray across, when it and the larva both disappeared to the bottom. I could not ascertain by what means the larva was supported until it had become accustomed to the hole at the side of the glass jar. Then I discovered that the larva was drawn up into the most extraordinary position, the thoracic segment "close-hauled" under the chin, bending round at the fourth abdominal one in a backward curve, until the large prominence on the fifth was brought under and pressed against the thorax, the two vertical spines at the top being driven into the side of the burrow. The anal segment curled round to the opposite side, into which the spines were driven, so holding the larva up most securely. Thus, the body, when seen sideways, formed a perfect zigzag or letter S (Fig. 3).

Fig. 3.—Larva "on the Watch."

Noticing that the larvæ frequently jerked up their heads without any apparent reason, I placed a box on my window-sill, and when there I observed a number of small spots of a dirty fluid appear on the window two feet above the box. I then placed a piece of paper at that distance above, and found the spots appear on the underside, proving that the larvæ performed the trick, as I imagined, to create a disturbance among the various flies moving about. Thinking that they were able to seize their prey before it crossed the pitfall, I placed flies near, and, when within half an inch, they vanished with such rapidity that I could not at first detect the movement; but on holding a fly between the pliers I brought it within a quarter of an inch of the front of the head, and though the larva evidently saw it, it did not attempt to seize it until it had quietly lowered itself down the hole, reappearing in a few moments with the back of the head turned towards the fly, which was instantly seized by the larva springing out and striking the fly from above; the movement reversed, when larva and fly disappeared in the dark abyss. I gradually increased the distance so that I could entice the larva to repeat its attempt several times; this was done until I found that a fly could be reached when placed five-eighths of an inch from the hole, the larva always throwing itself backward. When making these long shots, as I term them, from the hole, the larva would sometimes retain its hold on the fly while I did the same, so that I was enabled to see that it was in some way held in its burrow. By a careful arrangement of silken cords attached to the dead fly, I was able to draw it near whilst I examined the movements of the larva from the light side of the glass. Waiting until one was quietly resting in the zigzag position, I placed my eye to the fixed magnifier, drew the cord, bringing the fly towards the hole, and from a slight movement I concluded that the larva had seen it. An eighth of an inch nearer and out sprang the tiger from its den, the body from the first to the eighth segment being arched backwards above the level of the vertical hole. The fly was seized and held fast by the tiger and my cord. A regular "tug of war" commenced, during which I had time to see that the larva was securely anchored in its burrow by the long dorsal pair of spines on the fifth abdominal (ninth from the head) segment being driven deep into the side of the burrow just below the pitfall, and to still further strengthen its hold the anal spines were driven into the opposite side.

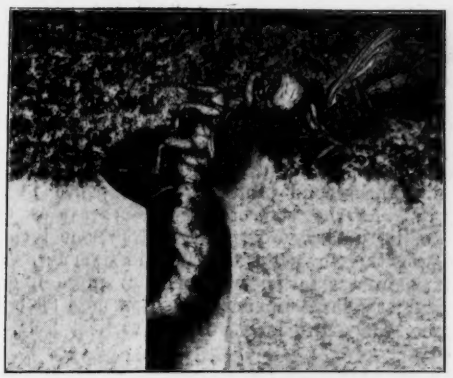


Fig. 4.—Larva: Act of seizing its Prey.

Thus securely anchored, the larva could defy any attempt made by its struggling prey to drag it from its lair (*see* Fig. 4). As soon as I released my hold on the silk cord, all

disappeared below in a moment. The fly was sucked dry, its old skin taken to the top, and shot away. Thinking that the larva caught flies on the wing, I tied a dead blowfly to a piece of silk, which I dangled backwards and forwards over the holes, until it swung within half an inch of one, when the occupant sprang up and seized it. I then watched day after day, until I was rewarded by seeing a larva spring up and catch a blowfly as it flew over the box.

The larvæ continue feeding until the beginning of October, when they deepen their burrows, using the sand excavated for blocking up the holes. The larva then retires to the bottom, remaining there in a semi-dormant condition, and entirely without food. The approach of spring soon rouses it to activity again, and the hole is reopened. Another six months' useful work is passed away, and once more the hole is blocked up during the second winter, to be reopened in March or April. At the end of July it excavates at the bottom of its burrow a very large cavity, one inch and a half long by three-quarters of an inch in diameter. This is sometimes in a slanting position, but more frequently horizontal; the large amount of sand is used for blocking up almost the entire length of the vertical hole. The

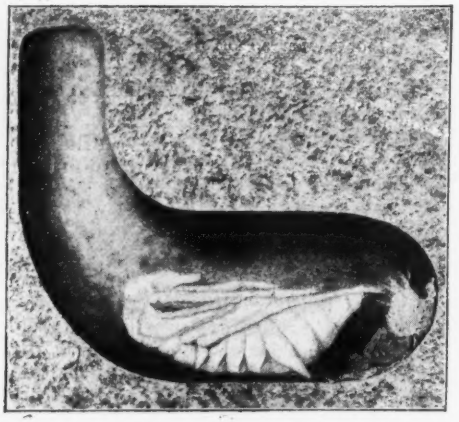


Fig. 5.—Pupa.

larva then rests upon its back, keeping the head under the original burrow, while the body is supported by the thoracic plate. This, and the large protuberance on the fifth, so raise it that no part of the delicate skin can touch the rough particles of sand.

Here it rests some seven to ten days, when the larval skin splits at the back of the head, and is quietly cast or slipped off towards the tail, the thorax again protecting the body, and in place of the prominence and spines on the fifth abdominal segment are two fleshy processes projecting somewhat from each side, surmounted by a brush of stiff spines. Smaller and similar processes are evolved on the first to fourth abdominal segments, which act in conjunction with the main pair, so that when the larval skin has been cast, the delicately white and flaccid pupa is hoist well up and clear from injury by any contact with the sand (Fig. 5). When seen from the end the pupa looks much like a ship on the stocks.

When first evolved every organ is pure white, but in the course of a week the eyes change to a yellowish colour—the mandibles, too, are clearly defined beneath the delicate membrane in which each part is enclosed. In another few days a most exquisitely delicate green colour spreads over the head, legs, and elytra; this increases in another week, until the creature somewhat resembles a lovely opal. The legs soon change to dark green, and the tiny bifid claws begin to twitch; this is followed in the third week by the legs showing some impatience to be doing something. Towards the end of the fourth week they commence to kick against the roof of the sepulchre, until the membrane splits and very gradually is worked off the head and thorax, the latter taking the weight of the now fast

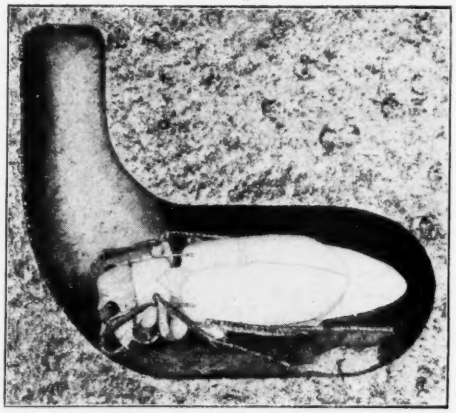


Fig. 6.—Beetle just evolved from Pupa.

maturing beetle. As the pupal skin is shrivelling up, it reaches the first pair of prominences on the abdomen and sweeps them clean away, one after the other, until the large fifth segment is reached; and though during two years and a half it played such an important part in the life of the larva—and in a modified form in the pupa—the beetle has no need of such a marvellous apparatus, which is entirely suppressed and cast away as a worn-out garment, though they are frequently economically disposed of by being eaten by the owner. The beetle, after several attempts, manages to turn itself over upon its legs; the wings are stretched out to their full length beyond the tips of the half-open elytra (Fig. 6). Three or four days are passed before the beetle assumes its full colours and markings; then it begins to show its hereditary temper and dislike to being looked at, for my attempts to examine it were frequently frustrated by the tiger plastering up the glass. However, in spite of such interruptions, I managed to observe and draw everything in order.

The beetle does not (as one would imagine) proceed to ascend to the surface, but it remains in its sepulchre a third winter.

The approach of spring can be felt even ten or twelve inches below the ground, and the beetle commences to extricate itself from its living tomb by ascending the original burrow, which is enlarged (Fig. 7), and all the sand removed by endless labour, the mandibles penetrating into the hard sand, which is simply dropped down into the

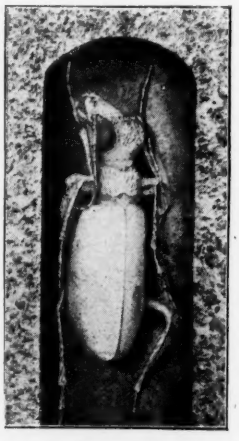


Fig. 7.—Beetle excavating and ascending to Surface.

sepulchre from which it was taken. The cycle is now completed, and the now gorgeously clad tiger beetle soon reaches the surface; and after carefully pluming those most important organs the antennæ, as well as every other part of its body, it, for the first time, stretches its wings and flies away.

THE CHEMISTRY OF THE STARS.

By A. Fowler, F.R.A.S.

ALTHOUGH actual specimens of celestial bodies cannot be subjected to the ordinary processes of chemical analysis, something can be learned by the aid of the spectroscope of the chemical composition of those bodies which are self-luminous. Quite naturally spectrum analysis was first employed in the investigation of sunlight—or, rather, it was the investigation of sunlight which pointed the way to the beautiful method of analysis which has evolved step by step from the experiments which Kepler and Newton made with a simple prism.

The discovery by Wollaston of the dark lines which break the continuity of the gloriously coloured band forming the solar spectrum, their subsequent mapping by Fraunhofer, and their interpretation by Kirchhoff, are points which need not now be dwelt upon, except to remark that the matching of the dark Fraunhofer lines with the bright ones seen in laboratory experiments, when the vapours of various substances are rendered incandescent, is a perfectly definite indication of the presence of corresponding vapours in the sun's atmosphere. Applying this method of comparing solar and terrestrial lines, the labours of Kirchhoff, Angström, Thalen, Lockyer, and others have demonstrated that most of the familiar metals enter into the composition of the sun's absorbing atmosphere.

The same principles hold good when the spectroscope is applied to the investigation of the chemical constitution of those stars which, like the sun, give spectra characterized by lines of absorption; while for stars which give out a bright line spectrum, the investigation by comparison spectra is still more direct.

Fraunhofer led the way in applying the spectroscope to the stars, and although the real significance of what he saw was unknown to him, he clearly recognized that some stars in a general way resembled the sun, while others were vastly different. His earliest observations were made with a theodolite, having a small prism placed in front of the object glass; but he afterwards obtained a four-inch telescope provided with a prism of the same aperture.

It was not until the announcement of Kirchhoff's interpretation of the Fraunhofer lines that this pioneer work on the stars was duly appreciated. Rutherfurd, Secchi, Huggins, Vogel, and others, successively took up the inquiry and greatly extended our knowledge of stellar spectra, distinct types being clearly recognized. Owing to the difficulty in procuring large prisms, Fraunhofer's method of observation was not generally followed—Secchi alone utilizing it—and most of the observers named employed some form of spectroscope attached to the eye end of a telescope, in such a way that an image of the star under observation was projected upon the slit. Dr. Huggins was conspicuously successful in his attempts to secure photographs of stellar spectra, and one magnificent outcome of his work was the discovery of a long series of lines, produced by hydrogen, extending far beyond the violet end of the visible spectrum.

About ten years ago, Prof. Pickering, of Harvard College Observatory, recognized the great value of Fraunhofer's star spectroscope for the photographic registration of stellar spectra, and it is to his revival of this method that we owe many of the greatest advances of recent years. When employed for photography, the prism, or train of prisms, is fixed in front of the object glass with its refracting edge parallel to the celestial equator, so that the resulting spectrum lies along a meridian, and the necessary breadth of spectrum is then obtained by allowing the driving clock to be slightly in error so that the spectrum trails parallel to its own length. Needless to say, the rate of this trail must be carefully regulated in accordance with the brightness and declination of the star. A prism employed in this way is usually designated an "objective prism," and the whole instrument, when used for photography, has received the name of "prismatic camera."

One of the instruments employed by Prof. Pickering is capable of recording the spectra of stars as faint as the eighth magnitude, and although the spectra are on a small scale they sufficiently indicate the characteristic features. The immense advantage of such an instrument in a general survey of the stars is its capacity for registering a large number of spectra with a single exposure, as many as two hundred appearing on one plate. With instruments of greater dispersive power only the brighter stars can be photographed, and it usually happens that only one star at a time can be investigated; such instruments are therefore specially applicable to a minute analysis of typical spectra.

Prof. Norman Lockyer soon followed in the adoption of this method of work at South Kensington, and he has obtained spectra of great beauty and value with a six-inch telescope provided with a prism of forty-five degrees. Some of these spectra he has very kindly permitted us to use for the illustration of the present article, and this opportunity of inspecting them will doubtless be generally appreciated.

The plate which we reproduce shows the violet end of the spectra of six of the brighter stars—Bellatrix, α Cygni, γ Cygni, β Arietis, Procyon, and Arcturus—and the spectra are so arranged that lines common to them fall nearly in a vertical line; lines of hydrogen being marked H. It will at once be noted that some of the stars show only a few prominent lines, while in others strong lines cross the spectrum at short intervals from end to end. But among the spectra with numerous lines, as well as in the case of those with few lines, great differences are apparent.

The mere taking of a spectrum photograph, however good, does not advance matters very much. In the first place it becomes necessary to inquire into the chemical substances represented by the various lines, and the most obvious method is to directly compare the spectra of the stars with those of known substances, exactly as in the case of the sun. This method was, in fact, the first employed—by Dr. Huggins—but it is extremely laborious, and to take a photographic comparison with every known substance would be still more so. With the objective prism, indeed, such comparisons are almost impossible. Fortunately, the repetition of certain groups or series of lines renders such an undertaking unnecessary. To take a definite case: hydrogen lines having once been identified in a star by a direct comparison with the hydrogen spectrum, the recognition of the lines of this gas in a photograph enables the "wave-lengths" of all the other lines to be determined, and it only remains to compare these figures with those tabulated for the spectra of different substances.

Matters are much simplified by the fact that there are many stars which give spectra practically identical with that of the sun. Such a star is Arcturus; and a spectrum of this

kind, with its lines of known position, and frequently of known origin, serves as an admirable reference in determining the positions and origins of lines seen in other spectra photographed with the same instrument.

What, then, do we learn when the stellar spectra are "reduced" in this way? First, we have the fact that stars of the Arcturus class, which are very numerous, chemically resemble the sun so far as we are in a position to determine; and our knowledge of this type of spectrum is, therefore, practically limited by what we know of the sun in its most general aspect.

But, after all, if we measure our knowledge of the chemical composition of the sun's atmosphere by the number of Fraunhofer lines sufficiently accounted for, we know very little indeed. With appliances of the greatest possible delicacy, Prof. Rowland has recently gone over the ground again, confirming in the main the results obtained by his predecessors, and has considerably extended the list of solar elements. Nevertheless, more than sixty per cent. of the two thousand Fraunhofer lines shown in Rowland's magnificent photographs between F and D still rank among the "unknown" lines which remain to be explored, and, if possible, "run to earth."

There is, however, a possible explanation for some of the unknown lines. Although the spectrum of a substance is perfectly definite at a given temperature, a change of temperature is frequently accompanied by a corresponding alteration in the spectrum, and in such cases there will not be a perfect matching with the solar lines, unless the laboratory spectrum is produced at a temperature more or less approximating to that of the solar region in which the particular vapour is located. It may very well happen, then, that many of the "unknown" Fraunhofer lines really form part of the spectra of familiar substances under untried conditions, a view first advanced by Lockyer in connection with the theory of dissociation.

With regard to stars, the variations of spectrum with temperature are of special importance, for there is every reason to believe that some stars are hotter than others.

The spectra of Procyon and β Arietis, as shown in our illustration, differ mainly from that of Arcturus and the sun in their intensified hydrogen lines and enfeebled metallic ones. Many of the lines in these two stars have accordingly the same chemical origins as the Fraunhofer lines; that is, hydrogen, iron, magnesium, calcium, and so on.

The spectrum of γ Cygni presents several peculiarities, and has not yet been fully investigated. Its departure from that of a star like Arcturus, which it resembles in having a great number of lines, is much more considerable than a casual comparison would suggest, and most of its lines have not yet been certainly identified.

α Cygni presents us with a still more peculiar spectrum, hydrogen lines, however, being conspicuous. Many of its lines seem to coincide in position with lines of known substances, but they appear with such differences of relative intensity that it would be unwise to draw conclusions until laboratory experiments have indicated the possibility of similar changes of intensity in the lines of known substances. Excepting hydrogen, calcium, and magnesium, then, the lines of α Cygni remain without sufficient explanation.

The comparatively recent discovery of terrestrial sources of helium has resulted in the identification of many of the lines in such stars as Bellatrix which had previously ranked among the unknown lines. In the photograph of the spectrum of Bellatrix, which is reproduced, the three most intense lines are due to hydrogen, while seven of the other more prominent ones have been traced to helium; f is one of them. All the remaining lines are very feeble, so that stars of this class may be said to give visible indications of little besides hydrogen and helium.

Another group of stars, of which α Orionis is a good specimen, have spectra showing a great number of lines, together with a number of shaded bands or flutings. With regard to the lines, the identifications are even less advanced than in the case of stars like Arcturus; but Lockyer has shown that the dark flutings probably represent metallic vapours at a comparatively low temperature, while the bright ones, like those in comets, are possibly due to carbon.

Still another group of spectra is characterized by dark flutings, which have long been known to be either due to carbon or compounds of carbon. Little is known about the lines which also appear. But if the day should come when the "origin" of every line in the spectrum of any star should be known, we should not even then be in a position to assert that we knew every chemical substance entering into its composition. In the case of our own sun, which may be regarded as a star, our knowledge is enormously extended when the spectra of individual parts are separately investigated by projecting an image of the sun upon the slit, and by taking advantage of solar eclipses. This "taking the sun to bits," as Prof. Lockyer terms it, reveals the presence of certain substances round the sun—helium among them—which are not represented at all by Fraunhofer lines, and of the presence of which in the sun we should have remained in ignorance were it not for our very special relation to the sun in point of distance. There is, accordingly, nothing improbable in the idea that similarly situated vapours in stars may quite elude detection by the instrumental means now at our command.

More than this: the study of the relation existing between the different kinds of stellar spectra—a subject too great to be touched upon in the present article—indicates beyond all question a gradual evolution through successive forms with different temperature conditions. A common composition for all stars is, therefore, suggested, and differences of spectra on this view are caused by differences of temperature, some substances best giving comprehensible indications of their presence at one temperature, and some at another.

[I should wish to qualify one statement in Mr. Fowler's most excellent article, viz.: that "the relation existing between the different kinds of stellar spectra . . . . indicates beyond all question a gradual evolution through successive forms with different temperature conditions." This is certainly *one* interpretation which can be put upon that relation, but not the sole one. It assumes that the chemical elements known to us here are not only distributed through all celestial bodies, but distributed in equal proportion through them all; an assumption which appears to me not only gratuitous but inadmissible.—E. Walter Maunder.]

THE FACE OF THE SKY FOR MARCH.

By Herbert Sadler, F.R.A.S.

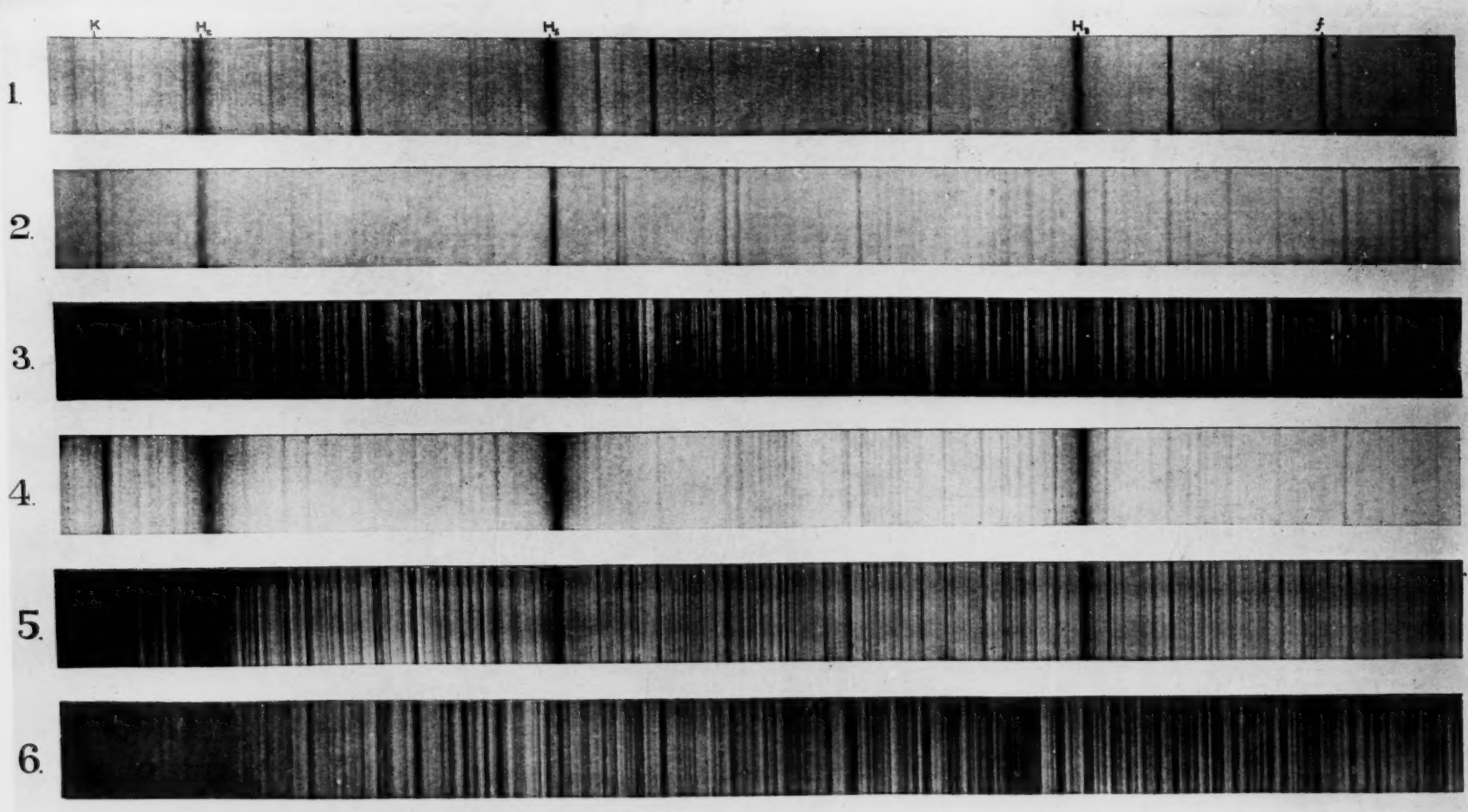
SUNSPOTS are occasionally visible on the solar disc. Conveniently observable minima of Algol occur at 10h. 0m. P.M. on the **7th**, at 6h. 48m. P.M. on the **10th**, and at 11h. 42m. P.M. on the **27th**.

Mercury is not well situated for observation during the month.

Venus is now a magnificent object in the evening sky. On the **1st** she sets at 10h. 10m. P.M., or four and a half hours after the Sun, with a northern declination of 13° 17′, and an apparent diameter of 28″, about $\frac{4}{10}$ths of the disc

STELLAR SPECTRA.

photographed at South Kensington with 6 INCH prismatic camera.



1 BELLATRIX. 2 α CYGNI. 3 γ CYGNI. 4 β ARIETIS. 5 PROCYON. 6 ARCTURUS.

Dir. Photo. Eng. Co

being illuminated. On the **5th** she sets at 10h. 18m. P.M., with a northern declination of 14° 57′, and an apparent diameter of 29½″. On the **12th** she sets at 10h. 26m. P.M., with a northern declination of 17° 37′, and an apparent diameter of 32½″. On the **19th** she sets at 10h. 29m. P.M., with a northern declination of 19° 54′, and an apparent diameter of 36″. She is at her greatest brilliancy on the **23rd**. On the **26th** she sets at 10h. 28m. P.M., with a northern declination of 21° 41′, and an apparent diameter of 40″. On the **31st** she sets at 10h. 21m. P.M., with a northern declination of 22° 36′, and an apparent diameter of 44″, about $\frac{9}{10}$ths of the disc being illuminated. During the month she pursues a direct path in Aries.

Mars is an evening star, but is rapidly getting fainter and smaller. He souths on the **1st** at 6h. 42m. P.M., with a northern declination of 25° 39′, and an apparent diameter of 8½″. On the **5th** he souths at 6h. 34m. P.M., with a northern declination of 25° 42′, and an apparent diameter of 8¼″. On the **12th** he sets at 2h. 55m. A.M., with a northern declination of 25° 44′, and an apparent diameter of 7¾″. On the **19th** he sets at 2h. 41m. A.M., with a northern declination of 25° 43′, and an apparent diameter of 7¼″. On the **26th** he sets at 2h. 27m. A.M., with a northern declination of 25° 37′, and an apparent diameter of 7″. On the **31st** he sets at 2h. 18m. A.M., with a northern declination 25° 29′, and an apparent diameter of 6¾″. During the month he pursues a direct path through a portion of Taurus into Gemini.

Jupiter is an evening star, and is well situated for observation. On the **1st** he rises at 4h. 46m. P.M., with a northern declination of 11° 7′, and an apparent diameter of 45½″. On the **5th** he rises at 4h. 27m. P.M., with a northern declination of 11° 18′, and an apparent diameter of 45¼″. On the **12th** he rises at 3h. 55m. P.M., with a northern declination of 11° 37′, and an apparent diameter of 45″. On the **19th** he rises at 3h. 23m. P.M., with a northern declination of 11° 53′, and an apparent diameter of 44½″. On the **26th** he rises at 2h. 51m. P.M., with a northern declination of 12° 7′, and an apparent diameter of 44″. On the **31st** he rises at 2h. 30m. P.M., with a northern declination of 12° 16′, and an apparent diameter of 43⅓″. During the month he describes a short retrograde path in Leo.

Both Saturn, Uranus, and Neptune are, for the observer's purposes, invisible.

There are no very well marked showers of shooting stars in March.

The Moon is new at 11h. 56m. A.M. on the **3rd**; enters her first quarter at 3h. 28m. P.M. on the **11th**; is full at 9h. 28m. P.M. on the **18th**; and enters her last quarter at noon on the **25th**.

Chess Column.

By C. D. Locock, B.A.Oxon.

Communications for this column should be addressed to C. D. Locock, Burwash, Sussex, and posted on or before the 10th of each month.

Solutions of February Problems.

(C. D. Locock.)

No. 1.

1. K to B3, and mates next move.

No. 2.

1. B to Ktsq, and mates next move.

Correct Solutions of both problems received from A. P. Hyatt, H. Le Jeune, Rev. F. W. Quilter, D.D., H. W. Elcum, W. Clugston, A Norseman, A. E. Whitehouse, W. H. Lunn, G. E. Hanson, Sigma, E. C. Willis, H. H. Thomas, W. D. J. Edwards, J. T. Blakemore, Captain Forde.

Of No. 2 only from G. G. Beazley and M. Wiedhofft.

T. Raddick.—Many thanks; the similarity you point out is certainly very remarkable.

W. H. Lunn.—We regret the omission, assuming that the solutions were sent in time for acknowledgment.

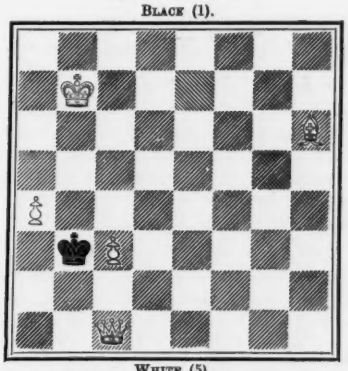
The following are sincerely thanked for responding to our appeal for problems:—P. G. L. F., E. Henry, W. Clugston, A. C. Challenger, Rev. F. W. Quilter, T. Raddick, J. T. Blakemore, P. H. Williams.

PROBLEMS.

No. 1.

By P. G. L. F.

Black (1).



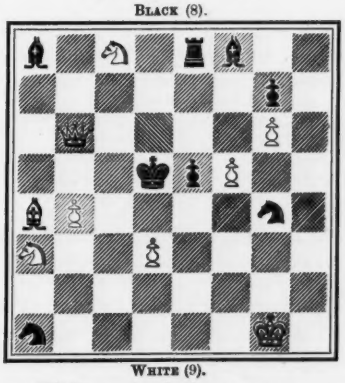
White (5).

White mates in three moves.

No. 2.

By Eugene Henry.

Black (8).



White (9).

White mates in two moves.

CHESS INTELLIGENCE.

The Second Cable Match between Great Britain and the United States took place on February 12th and 13th, the number of players on each side being increased from eight to ten. The British team played at the Hotel Cecil, London, the hours of play being from 3 to 7 and from 8 to 11.30 each day. Apart from the absence of Mr. Burn, who declined to play, both teams were considered fairly representative, though some advocated the claims of more than one English professional. In a shorter contest Mr.

Bird would hardly have been omitted, but, as it was, the nine amateurs for the most part gave a good account of themselves, and at all events succeeded in regaining the Newnes Trophy, which a team including several professional players lost last year. It is evident from the score that the British contingent had no tail, but the same is, probably, not true of the other side. The last game was concluded at 11.20 on Saturday night, the score being as follows:—

Great Britain.		United States.
1. J. H. Backburne (London)	½ v.	H. N. Pillsbury ½
2. C. D. Locock (Hastings)	0 v.	J. W. Showalter 1
3. H. E. Atkins (Leicester)	1 v.	C. F. Burille ... 0
4. T. F. Lawrence (London, City C.C.)	0 v.	J. F. Barry ... 1
5. D. Y. Mills (Edinburgh)	½ v.	E. Hymes ... ½
6. G. E. H. Bellingham (Dudley) ...	½ v.	A. B. Hodges ... ½
7. J. H. Blake (Southampton)	0 v.	E. Delmar ... 1
8. E. M. Jackson (London, St. George's)	1 v.	H. Helms ... 0
9. H. H. Cole (Ludgate C.C.)	1 v.	F. M. Teed ... 0
10. H. Jacobs (London, City C.C.) ...	1 v.	E. McCutcheon 0
	5½	4½

We append a brief account of the games:—

Board No. 1.—Mr. Pillsbury played the Two Knights Defence. Mr. Blackburne played a novel form of attack, and obtained the superior position. A weak move, however, resulted in his gradually drifting towards inferiority, until, by a very ingenious sacrifice, he succeeded in obtaining a draw by perpetual check.

Board No. 2.—Mr. Locock, in defending the Lopez, purposely played a weak move in the hope of tempting his opponent to win a Pawn by means of a temporary attack. Mr. Showalter, however, treated the move in a novel manner to which there was no defence, and the game soon became hopeless for Black.

Board No. 3.—Mr. Atkins, in a Vienna opening, had the superior game throughout, his opponent neglecting to preserve his Bishop by P to QR3. The game was prolonged till the board was almost cleared, but the result was never in doubt.

Board No 4.—Mr. Lawrence castled on the Queen's side in a close game, and lost two Pawns. He obtained some counter attack, but hardly made the most of it, and finally lost a piece and the game.

Board No. 5.—Mr. Mills obtained a slight superiority against his opponent's French Defence, but, exchanging all the pieces too soon, he discovered that his advantage in the Pawn position was not sufficient to win.

Board No. 6.—Mr. Bellingham defended the Lopez by 3. P to QR3 and 4. P to Q3. He had a slight inferiority of position for most of the game, till his opponent, in attempting to force a win at any cost, lost his advantage. The game was finally drawn on the sixty-ninth move. This gave the victory to the British side.

Board No. 7.—Mr. Blake obtained a pronounced advantage against his opponent's French Defence, but some weak moves subsequently gave the advantage to Mr. Delmar, who utilized it in a very ingenious manner to bring about a forced mate.

Board No. 8.—Mr. Jackson defended the Lopez by 3. . . P to KKt3; 4. P to B3, Q to K2; 5. Castles, P to Q3. Mr. Helms omitted to take the Knight, and shortly afterwards lost a Pawn and the exchange, remaining with a hopeless game.

Board No. 9.—Mr. Cole played a close game, and after twenty-five moves each side was left with a Bishop and five Pawns. Mr. Cole, however, was still a move ahead, and, playing the difficult ending in the most ingenious manner, he ultimately won the game on the sixty-fourth move.

Board No. 10.—Mr. Jacobs played the Centre Counter Gambit. His opponent unwisely exchanged Knights on the fourth move, and found himself compelled to move his King to Q2, in front of his Queen and QB, as early as his ninth move. As the result of this, Mr. Jacobs obtained a strong attack, which he conducted very cleverly to a successful issue on the twenty-seventh move. This was the first game finished.

The Annual Chess Festival at Hastings began on February 15th, with a consultation game between Messrs. Bird and Dobell against Gunsberg and Locock. The latter side turned Mr. Bird's P to KB4 opening into a From Gambit, and had a winning advantage as early as the ninth move, though Mr. Bird and his partner struggled on with a Rook to the bad until the thirtieth move.

In the evening Mr. Blackburne played about twenty-five games simultaneously. Play was rather slow, and several of the games were abandoned as drawn, the single player losing one or two as well.

On February 16th, Mr. Gunsberg and Dr. Colbourne consulted against Messrs. Blackburne and Chapman in a Giuoco Piano. The latter were soon compelled to give up the exchange for a slight counter-attack, which, at the time of adjournment, did not appear to be very dangerous.

KNOWLEDGE, PUBLISHED MONTHLY.

Contents of No. 186.

	PAGE		PAGE
Nansen's Waymarks to the North Pole. By W. F. Hume, D.Sc...	33	Letters:—"Underground Cavities and Streams in Ireland"—W. H. S. Monck; Eric H. Jackson; G. W. Bulman; T. W. Backhouse; Francis M. Duncan.....	49
The Science of the Queen's Reign: Sixty Years of Astronomical Research. By Miss Agnes M. Clerke. (*Illustrated*)	34	The Zodiacal Light. By Lieut.-Col. E. E. Markwick, F.R.A.S.	51
The Polar Bears at the "Zoo." By F. E. Beddard, F.R.S.....	39	Evidence of the Evolution of Stellar Systems. By Isaac Roberts, D.Sc., F.R.S.	53
A Pantheon of Science. By John Mills, F.R.A.S. (*Illustrated*).....	41	Periodical Comets due in 1897. By W. T. Lynn, B.A., F.R.A.S.	55
'Twixt Land and Sea. By Harry F. Witherby (*Illustrated*)	43	The Face of the Sky for February. By Herbert Sadler, F.R.A.S. ...	55
Science Notes.....	46	Chess Column. By C. D. Locock, B.A.Oxon.	55
Notices of Books	47		
Short Notices.....	48		

Two Plates.—1. Polar Bears at Play. 2. Photographs of Spiral Nebulæ in the Constellations Pisces, Ursa Major, and Canes Venatici.

NOTICES.

Bound volumes of Knowledge, New Series, can be supplied as follows:—Vols. I., II., III., and VIII., 10s. 6d. each; Vols. VI., VII., IX., X., and XI. (1896), 8s. 6d. each.

Binding Cases, 1s. 6d. each; post free, 1s. 9d.

Subscribers' numbers bound (including case and Index), 2s. 6d. each volume.

Index of Articles and Illustrations for 1891, 1892, 1894, 1895, and 1896 can be supplied for 3d. each.

TERMS OF SUBSCRIPTION.

Annual Subscription, 8s., Post Free.

"Knowledge" as a Monthly Magazine cannot be registered as a Newspaper for transmission abroad. The terms of Subscription per annum are therefore as follows:—To any address in the United Kingdom, the Continent, Canada, United States, Egypt, India, and other places in the Postal Union, the Subscription is 8 shillings, including postage; or 2 dollars; or 8 marks; or 10 francs.

For all places outside the Postal Union, 6 shillings in addition to the postage.

Communications for the Editors and Books for Review should be addressed Editors, "Knowledge," 326, High Holborn, London, W.C.